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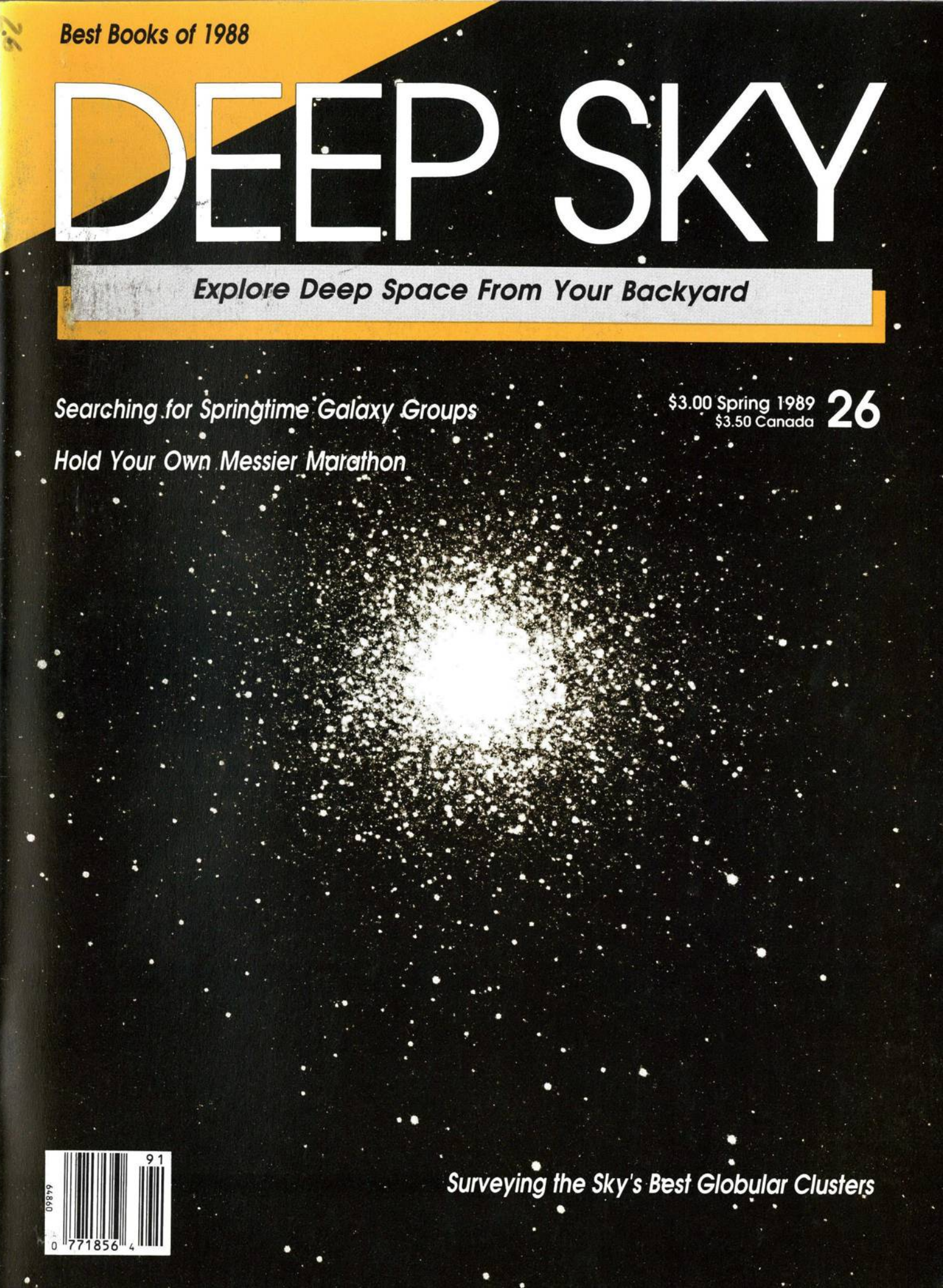

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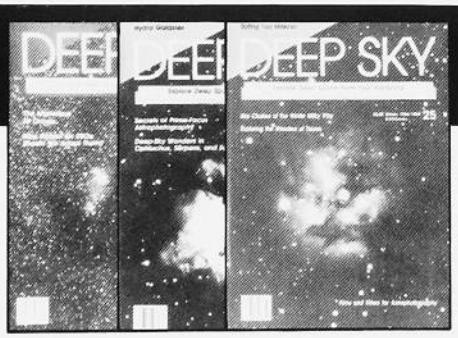

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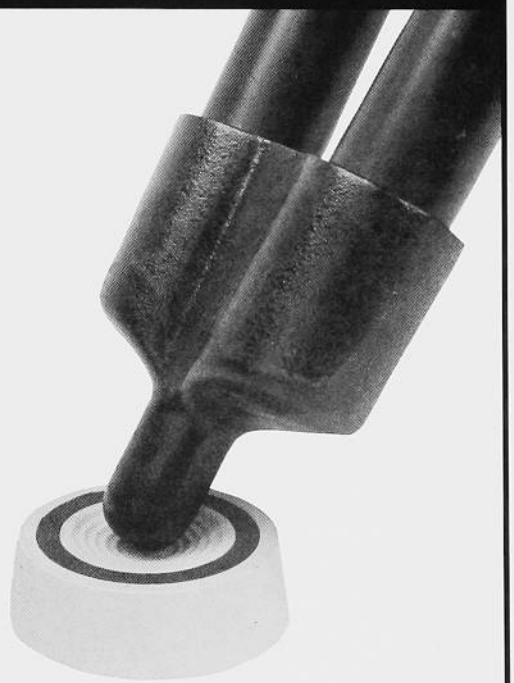

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THE MAGAZINE FOR DEEP-SKY OBSERVERS AND ASTROPHOTOGRAPHERS SPRING 1989 VOLUME 7, NUMBER 2

A Survey of Bright Globular Clusters for Backyard Telescopes
by Chris Schur

10 *Often ignored by amateur astronomers, globular clusters show subtle differences in backyard scopes. Chris Schur takes inventory of sixty-five globulars visible in small telescopes.*

Tracking Down the NGC 4005 Galaxy Group
by Robert Bunge

18 *What would you look at with a 31-inch telescope? Robert Bunge describes why he chose a little-known galaxy group for a large-scope observing project.*

A Trio of Springtime Galaxy Clusters
by Jeff Corder

22 *"No one ever looks at faint groups of galaxies," an observer once said. Floridian Jeff Corder highlights three distinctive clumps of galaxies for warm, springtime nights.*

6 Letters to *Deep Sky*
Galaxies Near NGC 4565
9 At the Eyepiece
Days of Clusters of Galaxies
28 *Deep Sky* Reports
The Messier Marathon: A One-Night Stand
Take the Cosmic Challenge!
Reader's Page
32 *Deep Sky* Reviews
The Best Deep-Sky Books of 1988
36 Small Scope Showcase
Springtime Discovery
38 Double Stars
Full Moon, Canes Venatici
40 Variable Stars
Seasons for Stars
42 Scanning the Literature
The Latest Research News

Cover: The Hercules Cluster, M13, photographed by Preston Scott Justis with a 10-inch f/6 reflector, 103a-O film, and a 40-minute exposure.

Opposite page: The M105 galaxy group in Leo photographed by Kim Zussman with an 11-inch f/10 SCT, hypered Tech Pan film, and a 150-minute exposure.

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At the Eyepiece
Days of Clusters of Galaxies

When I go to amateur meetings, I invariably end up standing at the eypieces of telescopes owned by newly-made friends. I hear all about the kinds of objects they like to observe. Over the past couple of years it's become obvious that clusters of galaxies are becoming popular with large-scope owners. Countless times at the Texas Star Party I've heard "Let's try for the Coma Cluster," or "Abell 1367 is rising."

Galaxy groups represent a type of object that could not be observed easily before the availability of large telescopes. The member galaxies are generally faint and small. Now, however, large-scope owners can see a great deal of these distant objects, including hints of detail in the brightest individual members.

Last year I received two manuscripts about tracking down galaxy clusters. Robert Bunge, an observer from Columbus, Ohio, had spent a number of nights studying the NGC 4005 galaxy group, a clump of fourteen galaxies that lies on the border of Leo and Ursa Major. Robert used an unusual instrument to observe the galaxies — a 31-inch f/7 reflector. His story of this little-known galaxy group begins on page 18.

Jeff Corder, a specialist in galaxy clusters who lives in Florida, also sent me a piece that includes data on the NGC 4005 group. Jeff's article begins on page 22 and highlights the NGC 4169 galaxy group in Coma Berenices and Leo's NGC 3937 galaxy group. All of these concentrations of fuzzballs are rarely observed — why not check them out on a clear springtime night?

Not to ignore other springtime deep-sky wonders. Chris Schur of Arizona is particularly fond of observing globular star clusters and has made an observational survey of sixty-five such clusters visible in small scopes. Chris' story stresses that, contrary to the old saying, globular clusters don't all look alike — each has a unique blend of characteristics.

This issue's departmental articles include Tom and Lynn Hoffelder's essay on the Messier Marathon (which includes a helpful list of right-angle sweeps so you can hold your own Messier Marathon), a compilation of particularly sticky objects to shoot for with your telescope by Phil Harrington, and a Reader's Page, inviting observations, from Steve Coe.

Also included in this issue is a wrap-up *Deep Sky Reviews* column focusing on the best books of 1988 for deep-sky observers. Last year saw the publication of James Wray's *Color Atlas of Galaxies*, NASA's *Atlas of Galaxies Useful for Measuring the Cosmological Distance Scale*, the second volume of *Uranometria 2000.0*, and others. What a year to be an amateur astronomer!

Yours truly,

Dave Eicher
Editor-in-Chief

Letters to *Deep Sky*
Galaxies near NGC 4565

Galaxies near NGC 4565

Dear Dave / The autumn issue of *Deep Sky* contained a beautiful photograph of NGC 4565 taken by Barry Sobel that captured the galaxy's dust lane remarkably well. Also in the photo is a distant cluster of galaxies Dr. Sobel inquired about.

Recently I checked the *Palomar Observatory Sky Survey (POSS)* at the University of California at Berkeley and identified the galaxies using the Dixon overlays. The mystery cluster was first mentioned by Fritz Zwicky in his *Catalogue of Galaxies and Clusters of Galaxies* (*CGCG*) at 1950 equinox position 12h35.0m, +26°05'.

The *CGCG* classifies the cluster as a "medium compact" group, a type characterized either by a "single, moderately compact concentration or by several distinct concentrations, some of which may be quite compact." Zwicky counted a total of 139 galaxies within the contour of this cluster, which extends to nearly 35' in diameter.

Finally, the cluster is classed as "very distant" because its radial velocity is between 45,000 and 60,000 km/sec/Mpc. Even on the *POSS*, this galaxy cluster appears insignificant. I don't think it is visible in amateur telescopes. Does any large telescope owner care to take on the challenge?

Steve Gottlieb
1020 Ramona Avenue
Albany, CA 94706

V Hydrae: Reddest Star in the Sky?

David / I just finished reading your autumn issue for the third time and couldn't help noting the excellent article on red stars by T. C. Hoffelder. I too have been observing red stars to add some variety to my observing program.

One red star that really stands out is V Hydrae. I first observed this distinctive star in 1985, and my notes from that year indicate it outdid R Leporis, R Scuti, and Mu Cephei in redness! On the first night I observed V Hydrae it appeared to be the same deep red color in my 8-inch f/6, 13.1-inch f/4.5, and 17.5-inch f/4.5 scopes. Fire-engine red didn't seem adequate to describe this star's color — it was incredibly red! However, by 1987 the star appeared to be more orange than red. I can hardly wait to look at it again.

Burnham's Celestial Handbook indicates that V Hydrae is a carbon star with two components, one brownish red and the other copper-red. The stars have a period of 530 days superimposed on a period of about 18 years. In private correspondence, Brian Skiff of Lowell Observatory tells me he sees it as a weird, dirty brown-red, like certain parts of a cool wood flame. He has uncovered a combined photoelectric B-V color index for the two stars of 5.5! In other words, there is virtually no blue light coming from this star. By comparison, Mu Cephei has a B-V of 2.26 and a typical blue star –0.25. Do these facts not place V Hydrae ahead of all others as the reddest star in the sky?

A. J. Crayon
Saguaro Astronomy Club
13819 North 37th Avenue
Phoenix, AZ 85023

Dear David / As usual, I am enjoying the most recent issue of *Deep Sky*. Particularly interesting was T. C. Hoffelder's "Blood on the Sky" with its many red stars to find and enjoy. However, it's too bad the list was limited to class N stars. Many M-, R-, and S-class stars are bright enough and red enough to have easily supplanted others on the list.

One of my favorites is the class R variable star T Lyrae. It is relatively easy to find, lying just 2° south-southwest of Vega. (It can also be found halfway between Zeta and Kappa Lyrae, as shown on the enclosed

map.) I happened across it one night early last year as I was following David Levy's advice to "cruise" a random area of sky and enjoy whatever happened to find its way into the eyepiece. (Thanks, Mr. Levy!)

I understand the limited nature of a listing like Mr. Hoffelder's, but I just couldn't resist getting a word in for a star that has elicited a "Wow!" from many an onlooker at star parties in this area.

Tom Lorenzin
P.O. Box 700-C
Davidson, NC 28036

Thompson's Mystery Objects

Dear Dave / Gregg Thompson's "mystery" object sketched in the letters section of the most recent issue of *Deep Sky* is undoubtedly the "bow tie" at the center of the brightest portion of M8, the Lagoon; indeed, an often overlooked feature of this much-scrutinized M object. Robert Burnham, Jr. calls it the "hourglass" and features a reasonably good photo on page 1,583 of *Burnham's Celestial Handbook*.

Thompson's sketch illustrates an important point concerning the human eye's much greater dynamic range versus that of photographic film. I have never seen a photo that matches the visual appearance of this object. The sketch printed in *Deep Sky* is a particularly fine representation of the high-power view through a medium-aperture telescope using a good nebula filter (Daystar, UHC, or O-III).

Tom Lorenzin
P.O. Box 700-C
Davidson, NC 28036

Dear Dave / Enclosed is a photo of Gregg D. Thompson's mystery object that was submitted to us readers in the Winter 88/89 *Deep Sky*.

Though, as Mr. Thompson says, the "hourglass" does exhibit a high surface brightness, I'm afraid it is not all that bright from my San Jose metropolitan-area backyard. However, I am looking forward to spending some pleasant hours next summer trying to improve upon it with a new scope and faster film.

As always the latest issue of *Deep Sky* was a joy to behold. Last night I toured the UU Aurigae group of double stars.

Ron Miller
2206 San Tomas Aquino Road
Campbell, CA 95008

Dear Dave / Reading about Gregg Thompson's "Mystery Objects from Down Under" in your summer 1988 issue was like renewing an acquaintance with an old friend. I believe the objects presented by Thompson are as follows: globular cluster NGC 6723 in Sagittarius, double star Brisbane 14 in Corona Borealis, and reflection nebulae NGC 6726-7 and NGC 6729 in Corona Australis.

I am familiar with this field because I have made several hundred visual magnitude estimates of the associated nebular variable stars R, S, T, and TY Coronae Australis on behalf of the Variable Star Section, Royal Astronomical Society of New Zealand. I observed this field frequently until 1986, when director Frank Bateson suggested that these stars be dropped from the observing list so we could concentrate on other types of variables.

Through my interest in this field I uncovered the following information that may be of interest to your readers. The observational descriptions are combined notes obtained using 6-inch and 16-inch reflectors.

The complex area of bright and dark nebulosity Thompson described is the R Coronae Australis T-Association, a region of recent and ongoing star formation in which a number of T Tauri stars and pre-main sequence objects are associated with the nebulosity.

Discovered by William Herschel, the brightest portion of nebulosity is the double nebula NGC 6726-7, easily located 1° west of the magnitude 4.2 star Gamma Coronae Australis. NGC 6726-7 is a wonderful object that consists of two large, bright, and nearly circular nebulae, each centered about a single bright star. The nebulae are in contact, forming a "figure 8" pattern in p.a. 30°. Each nebula is nearly 3' across, diffuse, and rather featureless in character. NGC 6726 is the southwestern object and is a little larger and brighter than NGC 6727.

The central star of NGC 6726 is HD 176386, an A0 object with no emission features. NGC 6727 surrounds the fainter star, a variable designated TY Coronae Australis. This star still has us all guessing. Variability was first reported by Innes, who considered it an eclipsing system with a period of 26 days. This was later reduced to 13 days, 6.90 days, and finally 2.8888 days. Further observations suggested variations consistent with those of an irregular nebular variable. Subsequent to this, however, in 1982 TY CrA was reclassified as an eclipsing system. This star's spectrum is that of a relatively normal B8 object. (Readers should note that volume one of *Sky Catalogue 2000.0* incorrectly lists TY CrA and HD 176386 as the same object.)

The temperatures of these stars are on the order of 10,000 to 12,000 kelvins, which is insufficient to ionize the surrounding nebulosity. This is confirmed by the spectra of these nebulae, which are almost identical to that of the bright stars, and indicates that NGC 6726-7 are visible only by light reflected off solid dust particles.

Lying 5' southeast of the nebulae are the smaller and somewhat fainter nebula NGC 6729 and its associated nebular variables R and T CrA. NGC 6729 is an elongated, comet-shaped nebula measuring 1.0' by 0.5' and is oriented in p.a. 120°. There is a single faint star, R CrA, embedded in the northwestern end of the nebula. Immediately to the southeast and involved in the nebula's faint, outlying extremities, is T CrA. This star is generally the fainter of the two and usually requires a moderate-size telescope to follow during its cycle.

R CrA is a typical member of the T Tauri class and is thought to be still in the process of contracting from the parent nebulosity. This star is the prime source of illumination for NGC 6729.

This type of variable star is always associated with regions of dark nebulosity and bright reflection nebulosity composed primarily of fine dust particles. As is the case with NGC 6726-7-9, spectra of these nebulae are almost identical to those of the associated stars, which confirms that we are viewing reflected light in the nebula. Such stars are typically giants of spectral class F, G, or K, which don't have temperatures high enough to cause ionization. Emission lines present in the spectra of these nebulae apparently result from collisional excitation, while those in the stellar spectra originate in the stars' chromospheres.

Light variations in the T Tauri stars apparently result from variable circumstellar extinction because of star-size dust concentrations moving in Keplerian orbits at planetary distances — light from the stars gets blocked.

Careful, long-term observations of NGC 6729 show the star varies both in size and brightness. These variations appear to result from random illumination of fixed nebular features as differing amounts of light from R CrA cause the features to brighten and fade over time but remain intact with no change in relative position. There is no clear correlation between variations of the star and the nebula.

Typically R CrA varies between magnitude 11.2 and 13.5 while T CrA remains between magnitudes 14.5 and 15.5. A third relatively bright T Tauri variable, S CrA, is situated 9' west of NGC 6729 and varies between magnitudes 11.5 and 13.0.

Within the same low-power field and 14' southwest of NGC 6726-7 is Brisbane 14, a bright, well-separated double star with nearly equal components (mags. 6.6 and 6.8, sep. 12.7", p.a. 281°). The western star in this fine pair is a little fainter than the primary and both stars are stark white in color. Each is a main-sequence star in which common proper motion suggests a long-period binary system. Only a slight decrease in position angle has occurred since it was first measured by John Herschel in 1837. Surrounding Brisbane 14 is the faint filamentary nebula IC 4812, an outlying region of reflection nebulosity associated with the NGC 6726-7-9 complex. Interestingly, IC 4812 is misplotted on *Sky Atlas 2000.0*, where it is shown almost 1° east of its true position. Yet the accompanying catalogue (*Sky*

Catalogue 2000.0, vol. 2) correctly lists Brisbane 14 (HD 176269-70), in the proper position, as the illuminating star.

The globular cluster NGC 6723 is easily located 20' north of Brisbane 14. Visible in binoculars, this bright cluster is well resolved in a 6-inch reflector. Discovered by James Dunlop in 1826, NGC 6723 is round, about 5' across, and contains stars of magnitude 13 and fainter.

Another object in the area that shouldn't be missed is the delightful double star Gamma CrA (mags. 5.0 and 5.2, sep. 1.7", p.a. 156° in 1982). This is a beautiful pair of close but clear separation and nearly equal light in which both components are yellowish in color. The fainter star lies to the southeast.

The region around the R CrA nebular complex, Thompson's Mystery Objects, shouldn't be missed by anyone far south enough to see it.

Peter F. Williams
3 McAuley Close
Heathcote 2233
New South Wales, Australia

Taurus Lost

Dear Dave / I just received the Winter *Deep Sky* and found a problem in my Taurus article. Several paragraphs of the article were apparently omitted from the published version. In the paragraph on NGC 1432 at the top of column four on page 21, the discussion of NGC 1432 is dropped midway and the discussion shifts into Alcyone. I hope that readers didn't hit too hard of a wall when they encountered it!

Phil Harrington
54A Dillmont Drive
Smithtown, NY 11787

Will the Real NGC 3999 Please Stand Up?

Dear Dave/ The position for NGC 3999 listed in the *Revised New General Catalogue* is wrong. *RNGC* errata hunters Steve Gottlieb and Brian Skiff have both noted that the *RNGC* position does not agree with Lord Rosse's drawings and notes. Inspection of the *Palomar Sky Survey (POSS)* plates shows a bright, stellar galaxy in the position that agrees with Lord Rosse.

To further complicate matters, when I inspected the *POSS* plates I saw a very faint galaxy at the *RNGC* position. *POSS* does show a very faint galaxy at the *RNGC* position. This galaxy appears to be a faint face-on spiral. Apparently during their survey the *RNGC* authors mistook this galaxy for NGC 3999.

Dreyer's *New General Catalogue* describes NGC 3999 as very faint and small. The galaxy at the erroneous position was difficult to see on the *POSS* plate, and it would not surprise me if it was too faint for Rosse to see even in his 72-inch scope.

The proper equinox 2000.0 position for NGC 3999 is right ascension 11h 59.3m, declination +24°56'. Because the wrong position is listed in the *RNGC*, the galaxy is also misplotted in *Uranometria 2000.0*.

Robert Bunge
110-1/2 Wilbur Avenue
Columbus, OH 43215

Going Deep in Canes Venatici

Dear Dave / When it comes to large, bright galaxies it's hard to beat Canes Venatici. However, there is also another aspect of this constellation that appeals to deep-sky lovers. The fact that Canes Venatici passes directly overhead for Northern Hemisphere observers makes it possible to test the magnitude limits of your scope by using galaxies in the constellation.

Recently Bob Ross and I attempted this at our observing site in the Pawnee National Grasslands of northeastern Colorado. I had just finished using Bob's *Uranometria 2000.0* to glimpse seven members of the Perseus A galaxy cluster when I decided to try for an extra in Canes Venatici.

My starting point was the star 67 Ursae Majoris near the Ursa Major-Canes Venatici border. The triangle of 8th-magnitude stars used to find the starting area is centered roughly on the border at +43° declination. Next to the central star of this triangle was my target galaxy, 11.6-magnitude NGC 4111. On the other side of a double star from NGC 4111 is NGC 4117, a faint galaxy glowing at magnitude 14.5. Near one of the other triangle stars lies UGC 7089. Because I don't have a copy of the *Uppsala General Catalogue*, I don't know this object's magnitude. But I estimated it at about the same as NGC 4117's. Both NGC 4117 and UGC 7089 appeared round and each had a very low surface brightness.

About 3/4° northeast of NGC 4111 is the 12.3-magnitude oval NGC 4138, which displays a condensed core. A half-degree north lies the extremely faint galaxy NGC 4137. The *Revised New General Catalogue* lists this galaxy at magnitude 15.0, but this is a rough approximation. In any case, it was barely perceptible, although its companion, NGC 4135, was not.

Moving up to M106 (NGC 4258), I was greeted by mottling around the outer edges of this 9th-magnitude spiral. In the same field lies the fine 11th-magnitude edge-on galaxy NGC 4217. Only a few arcminutes away from NGC 4217 is the 14th-magnitude, roundish NGC 4226. Just west of M106 lies the small, round galaxy NGC 4248. At 14th magnitude, this galaxy serves as a good pointer to the even fainter pair NGC 4231 and NGC 4232. At magnitude 14.5, I could detect their glow but could not split their images at 120x.

Another attractive galaxy group lies on the other side of Canes Venatici, in the same field as the bright face-on spiral NGC 5371. Grouped on one side of a 7th-magnitude double star about 1/2° west of NGC 5371 are five galaxies within a few arcminutes of each other. The brightest of this group is a 12.3-magnitude oval designated NGC 5353, which has a close, round companion of about 13th magnitude, NGC 5354.

On nights like this I am reminded why I go out observing — I can't get enough of the wonders of the night sky!

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Unraveling the Puzzle of NGC 6630 and IC 4723

Dear Dave / On map 26 in Tirion's *Sky Atlas 2000.0* two planetary nebulae are plotted and labeled NGC 6630 and IC 4723. Both of the undersigned searched for these objects visually with 10-inch and 12.5-inch reflectors but could not detect them.

Strangely these objects are not listed in the *Sky Catalogue 2000.0* under any class of nonstellar object. Nor are they included in the *Index and Cross Reference of Planetary Nebulae*, which indicates that they are not planetary nebulae as Tirion's chart suggests.

NGC 6630 is listed in the *Revised New General Catalogue* as a "type 7" nonexistent object, yet Steve Quirk has photographed both 6630 and IC 4723 as the enclosed print shows. Both objects appear milky white and circular when magnified with a loupe. They have the overall appearance of distant galaxies.

Noting this, we used Corwin's *Southern Galaxy Catalogue* to try to identify them. This work lists NGC 6630 as a galaxy but IC 4723 was not listed. Nor did there appear to be another galaxy in the catalogue at that position.

The European Southern Observatory's Quick Blue Survey captured these objects on field 103, however, and the catalogue lists IC 4723 as a peculiar, knotty object in a cluster.

What's going on here?

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and Steve Quirk
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Digging for Open Clusters

Dear Dave / *Deep Sky* seems to get better and better. It's good to see more interest in "obscure" open clusters, even though one really needs professional sources to get any data on them. I use the rather cryptic and unwieldy *Catalogue of Star Clusters and Associations*, available from Willmann-Bell. Unfortunately though, common parameters such as integrated magnitude and number of stars are conspicuous by their absence.

Many articles on open clusters, including the excellent ones in *Deep Sky* Winter 1988/89, include angular diameter, magnitude, and number of stars. For objects not on *Sky Atlas 2000.0* and listed in *Sky Catalogue 2000.0*, volume II, the authors really have to dig for data. Tom Matty mentions the

Gosta Lynga catalog, which I didn't know about. Where can I purchase it? Is it out of print, only to be found in professional observatory libraries?

I discovered a small error in Rick Dilsizian's article, "Film, Filters, and the Facts of Life." On page 27 he notes that when using an Hα filter, you can't focus at infinity as you can when not using a filter. Correct, but this is not because you're adding another optical component. Other kinds of filters do not cause this difficulty. The reason you change the focus is that an Hα filter transmits such a narrow range of the visible spectrum (one outside the average correction of camera lenses) that the lens focuses it slightly behind the infinity point for "white" light. (See Sidgwick's *Amateur Astronomer's Handbook*, 4th edition, page 61ff.) This does not affect mirror-only optics.

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The 'Baby Scorpion'

Dear Dave / Among the many interesting articles and letters in *Deep Sky*, I enjoyed the letter from Mr. Hudak in the Summer 1988 issue about the Sailboat Cluster, an accidentally arranged group of stars on the celestial sphere in Leo Minor. Inspired by his imagination, I searched over the sky with my 7x50 binoculars and found a "baby scorpion" asterism in the southeastern part of Aquarius. It consists of five yellow stars glowing at 5th magnitude that are easily visible with the naked eye under fairly dark skies. These stars are designated 103, 104, 106, 107, and 108 Aquarii. 107 Aquarii is a fine double star with magnitude 5.5 and 6.5 components and a separation of about 6.5". It was an easy pair with an 80mm refractor at 30x.

With 7x50 binoculars a few stars from 6th to 8th magnitude helped me to see the "baby scorpion" in full detail. If you compare this asterism with the Scorpion, the only differences you'll find are a small disproportion in the positions of the stars and magnitude.

Two degrees north is beautiful R Aquarii, a long-period, peculiar, deep orange variable star, which is known as a "symbiotic star" because of its composite spectrum. This small part of sky with the "baby scorpion" and R Aquarii is well worth observing. Can anyone send me more facts about the stars in the "baby scorpion"? I would be grateful for any input.

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Righting UU Aurigae

Dear Dave / In the Winter issue Double Star column I mentioned a marked discrepancy between the catalogued magnitude of the companion to the red star UU Aurigae and its appearance on the *POSS* prints. When that article was prepared, I had not been able to find S. W. Burnham's original measures to see how he estimated the star's brightness and then perhaps learn the source of the problem.

Just yesterday I came across the necessary volume right on the Lowell library shelves. For the record, the work is titled *Measures of Proper Motion Stars Made with the 40-Inch Refractor at Yerkes Observatory in the Years 1907 to 1912*, Carnegie Institution of Washington Publication 168, published in 1913.

Anyway, to be brief, both the *IDS* and *WDS* entries for this object err in giving the separation as 17.9", whereas Burnham's star is at 227.9". There is indeed an 11th-magnitude star about 2' southwest of UU Aurigae. Thus, the star I mentioned in the article is not the catalogued one and the discussion there is more or less irrelevant.

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Remember the Small Scopes!

Dear Dave / I received my first issue of *Deep Sky* last week, and as a new subscriber I was happy to find almost every article had information for people like me who observe visually with a small scope. Starting with the letter from Tom Johnson through your Small Scope Showcase, *Deep Sky #25* gave me what I need as a new observer. I hope this is a trend you plan to continue. I realize that your magazine is slanted toward faint objects and large instruments, but the article on Taurus showed good balance between the large and bright and dim galaxies beyond the reach of my 6-inch f/15. I never even knew there were galaxies in Taurus.

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Winter Flaws

Dear Dave / I'm sad to announce a pair of errata in the Winter issue of *Deep Sky*. The obvious one was the transposition of the drawings of the Lagoon and Omega nebulae on pages 35-36; the only flaw in an otherwise superb article by James Lawrence. His method of preparing sketches that adequately represent the view through a telescope was ingenious and well presented.

The other error was in the article on the wonders of Taurus by Phil Harrington, in which the reader is left with the impression that neutron stars are formed in supernovae when protons and electrons are blown away by the forces of the explosion. Quite the contrary, the neutrons are *created* in a nuclear reaction in which the electrons and protons combine to form neutrons and neutrinos. The recent detection of the neutrinos from supernova 1987A in the LMC served as good evidence that physicists are on the right track in their theories of stellar core collapse. Also, the pulsar's very high rotation rate is caused by conservation of angular momentum, not gravity. The descriptions of the Taurus *objects*, however, were quite accurate.

These small errors have not dampened my enthusiasm for your magazine. I've always appreciated the greater depth to which deep-sky object visibility and telescopic appearance are treated. Keep up the good work.

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Crab OIII Emission

Dear Dave / In the fall issue (Letters to the Editor) I asked readers of they could explain the existence of a bright feature in the Crab Nebula that was evident with an O III filter but not evident in photographs I had referenced. David Frew from Sydney recently visited me and solved the puzzle by showing me two photographs of M1 taken in the light of doubly ionized oxygen published in Simon Mitton's book *The Crab Nebula*. The short exposure in O III clearly reveals a very strong O III region at the position depicted in my drawing.

I believe this feature was not so evident in other O III photographs I had referenced in other books because those exposures were longer, which caused many other fainter filaments to appear as bright as this region.

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Spotting Faint Galaxies in Pisces

Dear Dave / During a recent observing session with my 16-inch Dobsonian I came across a small cluster of galaxies in the Circlet of Pisces. The group's members include NGC 7696, NGC 7704, NGC 7705, and NGC 7706. They are plotted on chart 259 of *Uranometria 2000.0*.

Using a magnitude 8.5 star just south of the cluster as a reference point, I was able to pick out NGC 7704 and NGC 7706 without too much trouble. These objects are listed in the *Revised New General Catalogue* as having magnitudes of 15.0 and 14.5 respectively.

Along with NGC 7704 and NGC 7706, NGC 7705 forms a row. NGC 7705 was visible but only with great difficulty. At approximately magnitude 15.5, it was at the limit of what my scope could show on that evening.

Roughly 15' north of the line formed by the three NGC galaxies, I noticed a galaxy I have not been able to identify. The object appeared to be a nearly edge-on spiral with an estimated magnitude of 14.5 or 15.0.

Have other observers viewed this group and, if so, can anyone shed light on the anonymous galaxy?

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A Survey of Bright Globular Clusters for Backyard Telescopes

by Chris Schur

Cool, steady springtime nights offer excellent opportunities to observe the massive spheres of stars known as globular clusters. Many of these objects are brighter than 10th magnitude and larger than 10', which makes them easily visible in small telescopes. And many of the so-called spring and summer objects in Scorpius and Sagittarius remain visible throughout the first weeks of autumn, when for many observers seeing and transparency are typically at their annual best.

Open clusters such as the Beehive and the Pleiades have been known about since ancient times, but globular clusters remained undiscovered until 1665, when the German astronomer Abraham Ihle stumbled upon M22 while observing Saturn. During the following century Edmond Halley, Charles Messier, and Pierre Mechain added dozens of globulars to the list. Today about 150 are known to exist in our Galaxy, and hundreds more have been photographed in the haloes of other galaxies. In our survey we will consider globulars north of -40° declination bright enough to be visible in small instruments.

Let's start in the constellation of the great Sea Serpent, Hydra. Here we find two clusters near the serpent's tail, low in the southern sky for many Northern Hemisphere observers. The brightest of the two, **M68** (NGC 4590) is a showpiece object with a magnitude of 8.2 and a highly concentrated center. A 4-inch scope shows M68 as a hazy disk of nebulosity. A 10-inch scope provides a more impressive view, resolving the cluster's edges into dozens of stars.

The old saying "All globulars look alike!" is undoubtedly a falsehood.

For a more challenging globular, sweep eastward some 20° from M68 to the tip of Hydra's tail. There you will find **NGC 5694**, a cluster three times more distant than M68. Discovered by William Herschel in 1784, this object is small and dim, a 10th-magnitude blob some 3.6' across. When I observed NGC 5694 with my 12.5-inch and 16-inch reflectors, I detected no resolution even at high powers.

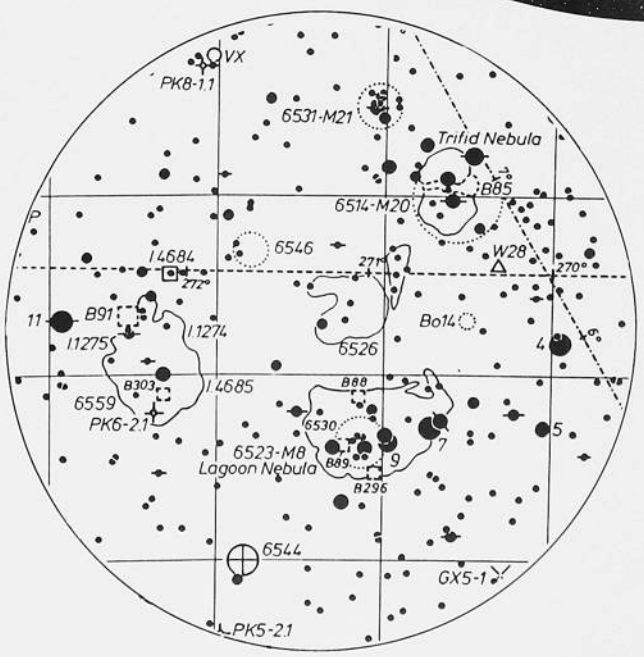
Moving north eastward near the Virgo/Libra border, we come to the only deep-sky object that isn't a galaxy in the region. **NGC 5634** is a magnitude-9.6 object measuring 4.9' across. With a 16-inch scope it appears to be composed of an unimpressive sprinkling of very faint stars at its extremities. After a long evening winding through Virgo's countless dim galaxies, you'll find this cluster a real treat for finishing off the night.

Farther east in Libra lies the loosely structured and distant **NGC 5897**. This cluster shines at magnitude 8.6 but is so spread out it appears faint because of its low surface brightness. A 16-inch scope shows thirty stars scattered over a rather unconcentrated faint background haze. Moderate magnifications work best; using too much power spreads the cluster out and yields an indistinct view.

North of Virgo is Melotte 111, the Coma Berenices star cluster. This area hides three diverse clusters, the most impressive being **M53** (NGC 5024). A large scope at medium power resolves M53 across its face and reveals hundreds of tiny stars. The cluster's core, however, appears as an unresolved nebulosity with a triangular shape. The disk itself appears about 8' across.

Only a degree southeast is a radically different object, **NGC 5053**. This cluster is nearly the same size as M53, but almost three magnitudes fainter. The stars of NGC 5053 are loosely distributed, which almost makes the object look like a rich open

King of northern deep-sky objects, M13 in Hercules is a spray of glitter in backyard telescopes. Photo by Jack B. Marling (10-inch f/5 reflector, hypered Tech Pan film, 15-minute exposure).

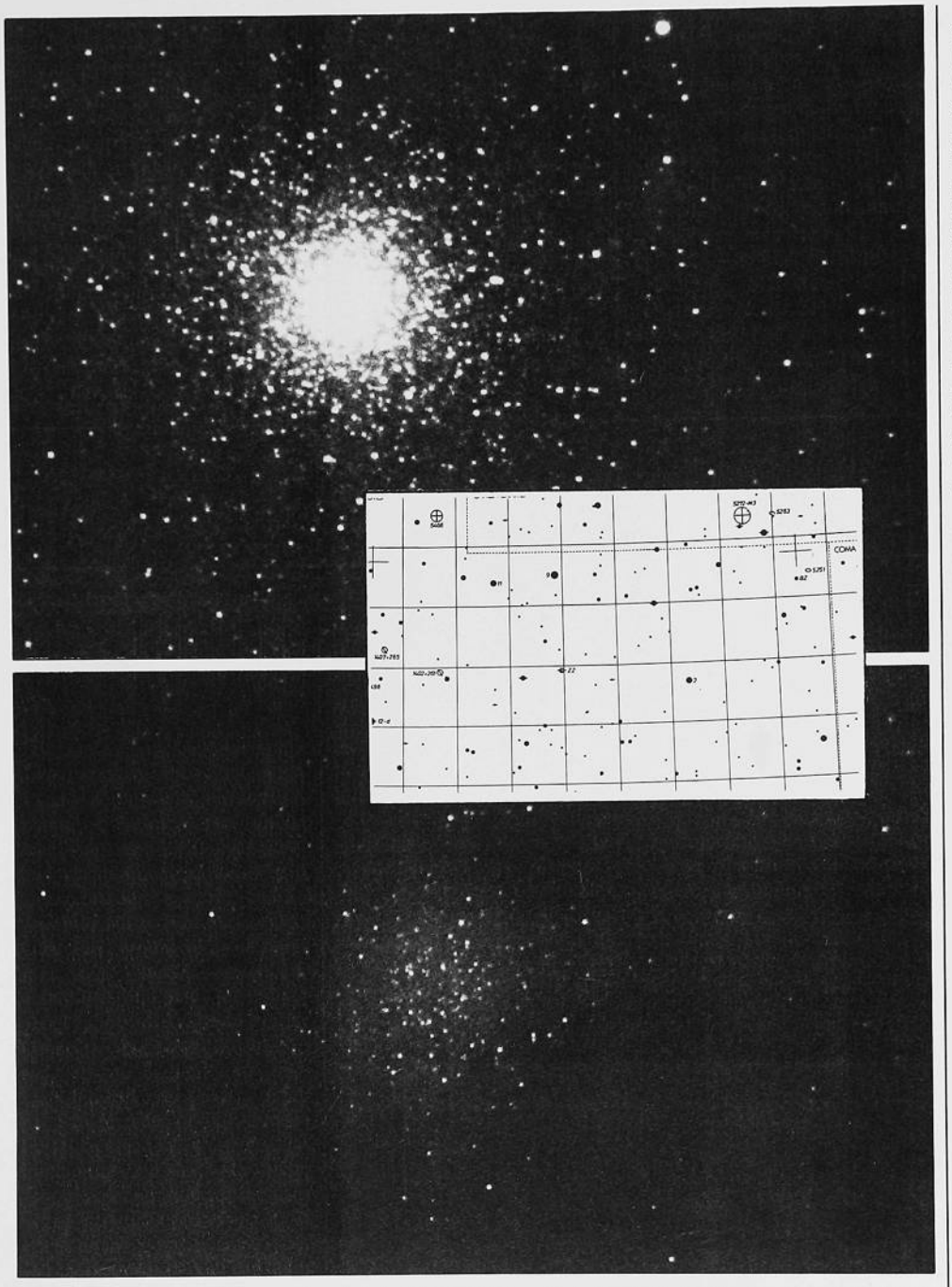


Dwarfed by the Lagoon Nebula, diminutive NGC 6544 in Sagittarius (lower left) appears like a tiny knot of faint stars. Photo by Gary Capps. Left: This Finder chart from Uranometria 2000.0 *shows the M8-NGC 6544 field. Copyright 1988 Willmann-Bell, Inc.*

cluster. With a luminosity of only 16,000 Suns, NGC 5053 rates as one of the intrinsically dimmest globulars known. With a 16-inch aperture NGC 5053 appears as a relatively low surface brightness object with little or no resolution. There is a slight concentration toward the middle, but it is extremely subtle. In a light-polluted sky it is easy to pass over NGC 5053 entirely, so observe it under a dark sky. Viewed together in a low-power field, the two globulars show a remarkable contrast.

Fifteen degrees west at the northern edge of the great Virgo galaxy cloud rests a small, faint globular known as **NGC 4147**. This cluster appears much like many of the numerous faint galaxies in this region. In 12.5- and 16-inch instruments I failed to resolve this group. The unique location of NGC 4147 makes it well worth the effort of finding. It's highly unusual to observe a globular so far from Sagittarius and so close to the Virgo galaxies!

Moving northward to the southern border of Orion's mythical hunting companion Canes Venatici, we encounter **M3** (NGC 5272). This object is one of the most brilliant, concentrated globulars in the northern sky. M3 shines at magnitude 6.4 and measures 16.2' across,



Top: M3 in Canes Venatici is one of spring's brightest globulars. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 35-minute exposure). Above: In stark contrast, loose NGC 5466 requires an 8-inch scope for a good view. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 30-minute exposure). Inset: Uranometria *chart shows the positions of M3 and NGC 5466. Copyright 1987 Willmann-Bell, Inc.*

so it is just visible to the naked eye on a dark, moonless evening. My 16-inch telescope at 90x shows M3 as a large, bright, central core of unresolved stars on which is superimposed countless faint specks of light. The stars are arranged uniformly, but some chains and streams of stars are visible toward the cluster's edge. On very dark nights averted vision nearly doubles M3's apparent size and causes it to spill out of a medium-power eyepiece.

About 4° east of M3, across the border with Bootes, lies the faint cluster **NGC 5466**. This large but tenuous cloud of stars is somewhat uncondensed in the center, but despite having a brightness of 9th magnitude, it is quite unimpressive in smaller apertures. In larger amateur scopes it is nearly completely resolved with hundreds of minute stars across its face. It can also sometimes be detected in an 8x50 finder as a ghostly patch in a star-poor region.

A constellation so named because you need catlike vision to see it, Lynx contains one of the sky's most unusual globulars. **NGC 2419** used to be considered an "intergalactic tramp," because its distance is 93.1 kiloparsecs -- almost twice that of the Large Magellanic Cloud. However, NGC 2419 is now known to be gravitationally bound to the Galaxy. The cluster glows dimly at magnitude 10.4 and measures 4.1' across, which makes it easily visible as a faint haze in small instruments. In a 16-inch scope at high magnification I couldn't resolve a single star in this group. (The brightest stars in NGC 2419 are slightly fainter than 17th magnitude.) Photographic exposures with the same size instrument, however, reveal dozens of faint stellar images at the cluster's edge. Although visually unimpressive, the thrill of examining a globular so remote makes an observing session a real adventure.

Because globular clusters form a spherical halo around the galactic core, looking toward the center of the Galaxy markedly increases the numbers of globulars visible. Scorpius contains seven impressive globulars, the brightest being the Messier objects M4, M80, and M62.

One of the brightest of all globulars is **M4** (NGC 6121). Located only 1° west of Antares, the heart of Scorpius, this relatively loose cluster shines at magnitude 5.9 and covers 26.3'. My 16-inch scope resolves hundreds of stars across the face of M4, which shows resolution right to its very core. Star chains are scattered all across the face of this object out to its extreme edges. The most notable feature is a prominent bar of bright stars bisecting the cluster in an east-west orientation. At high powers and on steady nights the bar breaks up into two long, parallel chains of stars.

Less than 1° east, near the brilliant orange light of Antares, is the faint globular **NGC 6144**. This cluster has a low surface brightness, and the light from Antares makes observing it difficult. Try using moderate to high powers and keep Antares out of the field. In a 12.5-inch reflector NGC 6144 appears as a faint nebulous glow surrounded by a fine dusting of faint specks. A solitary bright star lies several arcminutes away from one edge of the cluster.

M80 (NGC 6093) lies a few degrees to the north. On a good night M80's core appears brilliant and almost stellar.

Surrounding it is a moderately bright nebulous halo that gradually tapers off in brightness. M80 shines at magnitude 7.2 and measures 8.9' across, so it occupies most of a high-power field of view.

The third Messier globular in Scorpius is **M62** (NGC 6266). Lying near the Ophiuchus border, this showpiece shines brightly at magnitude 6.6. With a diameter of 14.1', the cluster is visible as a bright knot of gray light in binoculars. M62 has a relatively high surface brightness, so don't be afraid to use high magnifications on it when the seeing is good. In a 16-inch scope the entire cluster is resolved to the core with a fine smattering of stars all across its face.

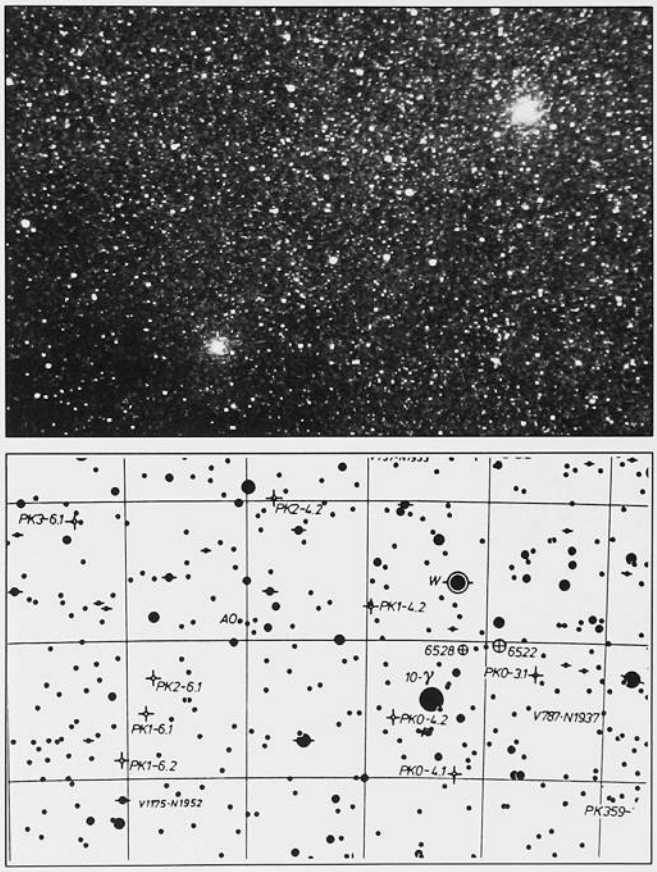
Three fainter globulars equally as interesting as the Messier objects lie in Scorpius. Just east of the Scorpion's stinger is the 3rd-magnitude star G Scorpii. The globular cluster **NGC 6441** lies 5' east of this star. Both objects are visible in the same medium-power field and offer a spectacular contrast. NGC 6441 is essentially unresolvable in amateur scopes, especially for those who live in the Northern Hemisphere. With a 16-inch scope at high power, averted vision reveals minute stars at the cluster's edges. The unresolved center is highly condensed: the nucleus does not appear stellar.

At the northwestern edge of the huge open cluster M7 is a small globular designated **NGC 6453**. With a low-power eyepiece you can observe this cluster with some stars of M7 also in the field. A 12.5-inch scope shows slight resolution on the cluster's edge, but NGC 6453 is faint enough (magnitude 10) and small enough (3.5') that it is difficult to resolve. The field surrounding NGC 6453 is extremely rich in stars and provides a spectacular backdrop for such a tiny globular cluster.

Another Scorpius object is the extremely reddened globular cluster **NGC 6380**, located near the star Q Scorpii. NGC 6380 and Q Scorpii are so close that at first the cluster seems easy to find. However, NGC 6380 is perhaps one of the most difficult globulars to observe from northern latitudes. Although it is nearly 2' in diameter and in a sparse field, NGC 6380 appears nearly stellar in backyard telescopes. The cluster is so faint that many observer's handbooks fail to list its visual magnitude. After many attempts I finally succeeded in locating this elusive object from a dark, high-elevation site with a 20-inch Newtonian at medium power. NGC 6380 appears small and has a 9th-magnitude star on its southern edge. No resolution was detected.

Northwest of Scorpius, Serpens holds a showpiece globular in **M5** (NGC 5904). This cluster is one of the finest in the sky and is visible to the naked eye at magnitude 5.8. In 16-inch apertures it brightens rapidly toward the center where piles of blazing stars can be seen with no dark spaces in between. Numerous star chains and star clumps overlay the cluster, filling the entire field of a medium-power ocular. Some observers report that in smaller instruments the core is angular in shape. This was not noticed with larger apertures.

East of Serpens is the large conglomeration of stars known as Ophiuchus. Contained within the borders of this star group are many globular clusters, six with Messier designations and many without. Two bright globulars are **M10** (NGC 6254) and **M12** (NGC 6218). The southernmost of the pair, M10, has a magnitude of 6.6 and measures 15.1' across. Viewed with a large backyard scope, M10 appears as a bright, moderately large globular that is completely resolved across its disk. The stars in this cluster seem to be lumped into two "layers" of brightness. There's an inner disk of dozens of stellar images crammed tightly together, as well as a halo some three times larger made up of scattered bright stars. Contrasting in appearance is M12, a similar sized cluster also shining at magnitude 6.6. In a 12.5-inch scope M12 appears different from M10, however. M12 shows a more uniform drop-off of surface brightness from the bright center out to the faint edge. M12 also shows many more curving branches of stars and star chains and seems to have a coarse appearance compared with M10's fine, misty look.



Top: Sagittarius' fine pair of globulars NGC 6522 (right) and NGC 6528 are visible together in a low-power field. Photo by Martin C. Germano (8-inch f/10 SCT, 103a-F film, 60-minute exposure). Above: Uranometria *finder chart shows the clusters' surrounding area. Copyright 1988 Willmann-Bell, Inc.*

Ten degrees due east is an intriguing trio of globulars well worth hunting down. The northernmost and brightest is **M14** (NGC 6402), a magnitude-7.6 cluster spanning 11.7'. Dimly visible in finder scopes as a faint star, M14 appears as a smooth glow of milky light peppered with stars in an 8-inch scope. I noticed no star chains or bright condensation in the nucleus of M14. Five degrees south of M14 is the second member of the trio, **NGC 6366**. This cluster appears as a medium-sized low surface brightness object with many tiny stars scattered across its pale disk. Very little central condensation was seen in larger telescopes; a few bright members were visible, however. The third member of the trip is the much fainter object **IC 1257**. No definitive classification exists for this object, which measures just about 1' across. It is possibly a remote, very dim globular. IC 1257 will challenge your observing skills, and you should feel accomplished if you find it.

A lone but worthwhile cluster lies on the western side of Ophiuchus. Shining at magnitude 8.1, **M107** (NGC 6171) is a strongly compressed globular covering 10.0'. Viewed with a large telescope, M107 appears mostly resolved across its face. The core is simply a granulated lump in the center. Averted vision is helpful in defining the outer edges of this object, which visually extend to 6' or 8'.

Two bright Messier globulars dot the southern end of Ophiuchus. **M9** (NGC 6333) requires medium to high powers for resolution and shows a bright, tight center at low magnification. Averted vision reveals hundreds of minute stars across its face, but mostly granular partial resolution remains in the core. The southernmost of the pair, **M19** (NGC 6273), is unique in that its central knot of

stars appears plainly oval at medium powers. It condenses toward the middle gradually, the main disk appearing overlayed with a fine dusting of hundreds of stars in large aperture scopes.

Just east of M9, a pair of small globulars invites comparison. The northernmost, **NGC 6356**, is easily visible in finder scopes. This moderately small glow smoothly brightens toward the middle, and at high powers in 16-inch scopes the extreme edges show dozens of very faint stars with averted vision. Due south is **NGC 6342**. This concentrated cluster is small and slightly elongated. My 12.5-inch scope fails to resolve the cluster at high powers.

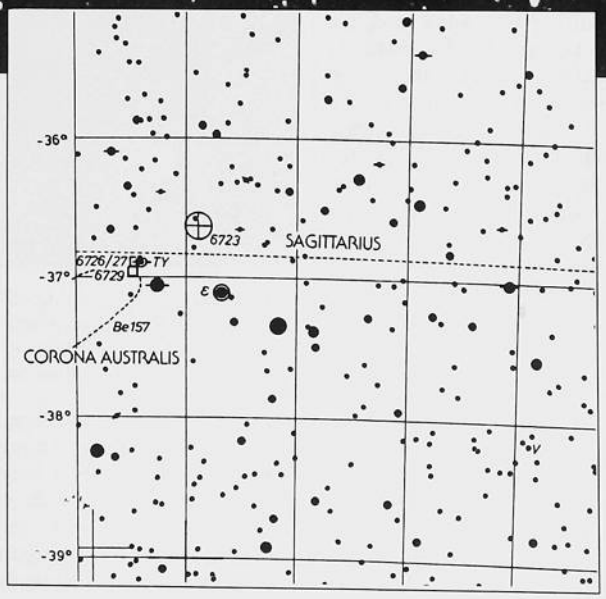
Another globular cluster with a low surface brightness, **NGC 6426**, lies near Gamma Ophiuchi in a rich starfield. This 12th-magnitude object demands dark skies for a good view. Situated in a rich starfield, two dozen stars appear scattered across an unresolved haze in 13-inch telescopes. As usual with a low surface brightness object, not too much central condensation was apparent.

Moving into Sagittarius, we find a region containing two dozen globulars. Some of the most spectacular objects in the sky appear in this region because it's so near the galactic center. Seven Messier globulars are in this region. The range is very broad from the visually dazzling M22 to the nearly unresolvable M54.

M22 (NGC 6656) is one of the brightest globulars in the sky. It is also one of the largest in angular size, approaching 20'. Blazing at 6th magnitude, M22 is easily visible with the unaided eye at dark sites. In a 16-inch aperture it is large and brilliant, well resolved across its face. The cluster shows a large circular disk that overlays the clumpy granulated core. Star chains are common in globulars, and M22 is no exception. I also noticed a wide range in brightnesses of the resolved members, from relatively bright orange stars overlaying the background bluish haze to faint white stars at the limit of detectability.

M55 (NGC 6809) stands alone on Sagittarius' eastern side. This large, 7th-magnitude ball of stars is hardly compressed in its center and appears as a faint but large cloud covered by a smattering of stars. Large scopes at medium powers show plentiful star chains in this object.

The globulars **M54** (NGC 6715), **M70** (NGC 6681), and **M75** (NGC 6864) are very similar in appearance. They are all



Globular NGC 6723 lies in a rich field of nebulosity in Corona Australis. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 30-minute exposure). Right: Uranometria *identifies the field nebulosities. Copyright 1988 Willmann-Bell, Inc.*

small and condensed gems with little or no resolution in moderate-sized amateur scopes. They condense rapidly toward the center to round, bright, central regions.

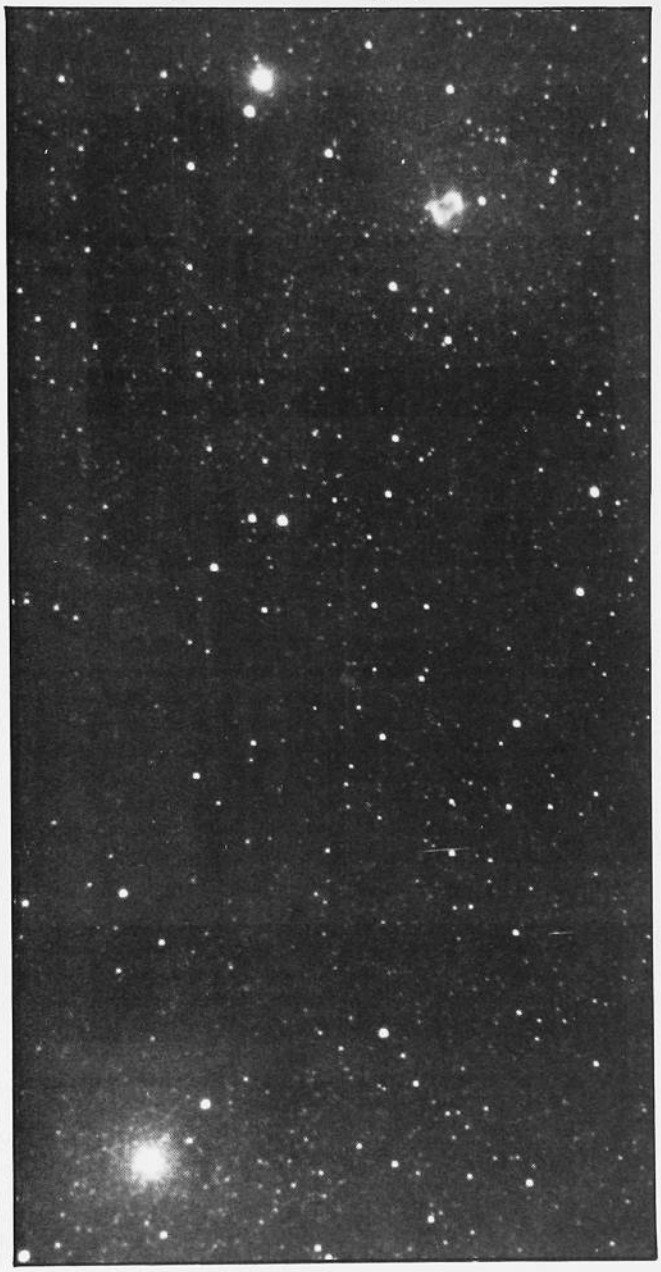
The globulars **M69** (NGC 6637) and **M28** (NGC 6626) are also similar in several ways. They are both moderate-sized objects with brightnesses of about 8th magnitude. In addition, about half of their disks appear resolved at high magnification in 8- to 12-inch scopes, yet the center-to-edge brightness transitions were very smooth. Neither object showed even a hint of resolution at its dense core.

Several interesting pairs lie in this region because of the locally high density of globular clusters. Less than a degree northwest of Gamma Sagittarii is the pair of clusters **NGC 6528** and **NGC 6522**. The pair will easily fit in a medium-power eyepiece. The westernmost of the pair, NGC 6522, glows at 10th magnitude and is the brightest of the two. This small object has a slight granular resolution in a 12-1/2-inch scope and condenses to a faint stellar nucleus in the center. A faint superimposed star is also visible. The easternmost member, NGC 6528, is quite dim, almost a low surface brightness object. It is slightly smaller and only gradually brightens toward the middle. The contrast of this pair is very striking, and their proximity invites comparison.

Another unique couple is the globular **NGC 6440** and the planetary nebula **NGC 6445**. At moderate glance they can appear as twins, similar in size and brightness; however, closer examination reveals that the northernmost member is an uncondensed patch, yielding its secrets more clearly with a fine nebular filter such as a UHC filter. The globular is for the most part unresolved, somewhat condensed toward its center, and with averted vision doubles in size.

Less than 1° southeast of the well-known Lagoon Nebula lies the small globular, **NGC 6544**. Buried in a very rich field, this ball of light gradually brightens toward the center and has a granular resolution even the highest magnifications possible. This neglected, 9th-magnitude jewel is quite easy in 8-inch scopes and would perhaps be better known if not for its proximity the nearby, showier M8.

One outstanding object you cannot miss lies in Corona Australis. Catalogued as **NGC 6723**, in a 16-inch aperture it looks like a miniature Omega Centauri, appearing as a large, diffuse disk of light with no central condensation. It only gradually tapers off in brightness from its center. With the combined light of a 6th-magnitude star, NGC 6723 contains hundreds of faint stellar points of an even brightness scattered across its face. Although low on the horizon for most Northern Hemisphere observers, NGC 6723 is a stunning object.



Top: The unusual pair of objects NGC 6440 (bottom left) and NGC 6445 are residents of Sagittarius. NGC 6440 is a tiny globular; NGC 6445 an odd planetary nebula. Photo by Martin C. Germano (8-inch f/10 SCT, hypered Tech Pan film, 50-minute exposure).

Moving northward into Scutum, we find another array of objects. The globular **NGC 6712** is a glorious object. This 9th-magnitude misty cloud contains a triangular-shaped central blaze of stars covered with a scattering of rows and chains. The whole field in fact is crammed with Milky Way stars in clumps and groups. If that were not enough, less than a degree east in the same low-power field is the large, 10th-magnitude planetary nebula **IC 1295**. Again a UHC filter causes its normally marginally detectable disk to shine through. A comparison of both objects with and without the filter at a wide range of powers is a real eye opener.

Farther north, we move into the constellation Aquila. This star group is known chiefly for its numerous planetaries and dark nebulae. However, at its southwestern side lies the lone globular **NGC 6760**. Besides being the only object of its class in the constellation, it doesn't have much else going for it. This 11th-magnitude blur appears in a 12-1/2-inch scope as a small and dim object, rather unconcentrated toward the middle. The cluster's entire face appears granulated at medium powers, indicating near resolution.

As we scan farther north still, we find three globulars within Hercules. There can be little doubt that **M13** (NGC 6205) is by far the most compelling object of its type in the northern sky. Although it is 23' in diameter, it is not the largest of the globulars. Yet its prominent position near the zenith makes it one of the most observed of all deep-sky splendors. In large scopes under dark skies M13 is completely resolved across its face, while the inner half contains a bright, unresolved, circular haze. Star chains are everywhere, about half a dozen of them forming huge, spiraling arcs. This gives the whole cluster a "spiral" appearance, first reported more than a century ago by Lord Rosse using his 72-inch Leviathon.

Nearby **M92** (NGC 6341) is only slightly less impressive. While only half the size and a magnitude fainter, it is still quite glorious with its tiny stars contracting toward the center to a tight core. The stars across its disk are more evenly distributed than in M13, with less star chains and clumps. At higher powers the central knot appears binuclear with two separate clumps of stars side by side.

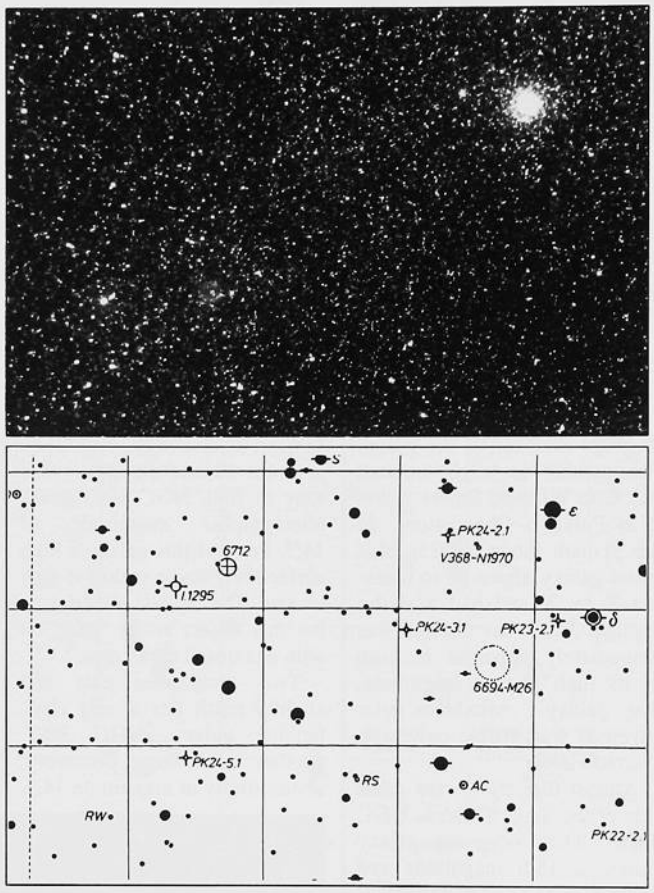
To complete Hercules, move north of the star 52 Herculis to find **NGC 6229**, a 9th-magnitude object that shows little resolution even in larger amateur scopes. The cluster appears mottled with a few stars occasionally popping in at the edges. The central condensation is nearly starlike and is surrounded by a dense, central haze.

Passing through the meridian for many mid-northern observers in late summer are the small constellations Lyra, Sagitta, and Delphinus. Lyra's only globular **M56** (NGC 6779), is a ball of haze, only 5' in size, yet at 8th magnitude it has a fairly high surface brightness. In 16-inch apertures at medium powers it appears as an unresolved central disk.

Farther south, Sagitta contains one globular, **M71** (NGC 6838). This cluster is a medium-sized, 8th-magnitude object and is arrow-head shaped in larger scopes. All of the stars contained in this gem appear of equal brightness with no central condensation visible. A very rich region of the Milky Way forms the backdrop.

Just east in the constellation Delphinus, two remote globulars lurk among the rich Milky Way fields. The brighter of the pair, **NGC 6934** glows subtly at 9th magnitude. In 8-inch scopes it appears as a small circular glow strongly condensed in the center with slight resolution at its edges. **NGC 7006** is another case entirely. Being one of the most remote bright globulars, it demands careful searching. At magnitude 11.5 it shines meekly in 8-inch apertures with little central condensation visible. No resolution at any magnification was detected. This globular is one of the most difficult to resolve, because even the brightest members glow at only 16th magnitude.

As autumn approaches, the number of globulars diminishes rapidly. **M30** (NGC 7099) in Capricornus is usually swept over in favor of more brilliant deep-sky riches farther north, yet it is the most impressive deep-sky splendor in this region of the sky. In 6- to 8-inch apertures this 8th-magnitude object is medium sized and partially resolved at the edges. In larger apertures the view is quite different: a strong central condensation is surrounded by star chains and arcs radiating outward, which gives this cluster a spiral appearance. In the past some observers with large scopes reported an oval appearance, yet this was not noticed by me in either 8- or 16-inch apertures.



Top: Scutum holds another strange pairing of objects in NGC 6712 (above right) and IC 1295. NGC 6712 is a tightly-packed globular and IC 1295 a ghostly planetary. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 35-minute exposure). Above: Uranometria *shows the field surrounding the two objects. Copyright 1988 Willmann-Bell, Inc.*

As we move eastward, Aquarius contains two fine Messier globulars and the difficult NGC 7492. The brightest by far is **M2** (NGC 7089). While only a third the size of the more famous M13 in Hercules, it is only a half a magnitude fainter, which makes it a condensed and spectacular cluster. In moderate apertures M2 is completely resolved across its face. In larger apertures, stars are piled up with no dark spaces in-between in the core and star chains extend off the edges in all directions.

Not to be overshadowed is **M72** (NGC 6981), a much smaller globular located in the western portion of the constellation. While it glows at only magnitude 8.5, this cluster's richness is impressive. Equally impressive is the fact that it is so difficult to resolve. With its brightest stars around magnitude 15.5, only slight resolution was detected across its disk in a 12-1/2-inch scope, with dozens of tiny stars popping in and out all around its edges.

Also in Aquarius is **NGC 7492**. Although listed as magnitude 12.5, its large size, very low surface brightness, and its low elevation make it an elusive target. In 16-inch scopes at medium magnifications NGC 7492 appears as a large, dim glow, with its outer boundaries barely detectable. Using higher powers on this object only makes it disappear!

Next, sweep northward to a particularly bright and concentrated object, **M15** (NGC 7078) in Pegasus. Easily visible in finders and shining brightly at magnitude 6.5, this grand globular is one of the finest in the northern sky. In smaller telescopes M15 shows a condensed background mist over which a rich scattering of evenly faint stars lie. In large scopes the view is breathtaking. The core is brilliant and nearly stellar with dozens of minute stars packed into an area of about 20". Star chains cover the face near the center and give the impression of an asymmetrical core.

Lying low in the southern constellation Sculptor is the beautiful globular **NGC 288**. Usually over shadowed by the giant, edge-on galaxy NGC 253 several degrees to the south, this object does not receive the attention it deserves. Shining at magnitude 7.2 and spanning 10', this cluster is one of the southern sky's best. The core appears as a triangular-shaped haze, with small stars strewn on top. Appearing rather three-dimensional, the two dozen or so stars across its face float in front of the cluster's inner, unresolved glow.

The final object in our survey is a vagabond in the heart of the winter Milky Way. **M79** (NGC 1904) in Lepus was first seen by Mechain in 1780 as an unresolved ball of light. Because its stars glow at 14th magnitude and fainter, you'll need a good 8- or 10-inch scope to detect some edge resolution. With a brightness of the 8th-magnitude, M79 can easily be seen in finders as a "fuzzy star" a mere 3' in diameter. In larger apertures tiny stars crowd in toward the center where a stellar nucleus is visible.

In our survey of bright globular clusters visible from the Northern Hemisphere, we've seen a tremendous variety of brightnesses, sizes, and degrees of resolution. There is no doubt that the old saying, "All globulars look alike!" is a falsehood. On the contrary, these balls of stars provide observers of all types with challenging and complex targets for telescopes of all sizes.

Chris Schur is an active observer and astrophotographer who lives in Arizona.

Tracking Down the NGC 4005 Galaxy Group

by Robert Bunge

A casual look through *Uranometria 2000.0*, volume I, can be very enlightening. While paging through the constellations of Coma Berenices and Leo, for example, you may see several groups of galaxies that appear on these beautifully crafted sky charts.

When I looked at these groups of galaxies, I decided I would pick a group and observe all of the galaxies in it. After looking all the groups over, I picked the **NGC 4005 group** 5° northeast of 93 Leonis.

This challenging, compact group of fourteen galaxies straddles the border shared by Leo and Coma Berenices. The brightest of these galaxies has a magnitude of 14 and the dimmest glows at about magnitude 15.7. All of these galaxies are small, yet at least a couple should show some detail in large backyard scopes.

To observe the group, I used the 31-inch f/7 Newtonian reflector at Warren Rupp Observatory near Mansfield, Ohio. Experience had taught me that my biggest enemy is the anonymous galaxies that often clutter fields in galaxy-rich areas of the sky.

While this may seem like a blessing, it can just as well be a curse. Identification of anonymous galaxies requires hours of homework and access to resources like the Palomar *Sky Survey*, the *Uppsala General Catalogue of Galaxies* and the *Morphological Catalogue of Galaxies*.

Since *Uranometria* does not show IC galaxies, I expected to see at least a couple of unplotted galaxies in the field. I turned the 31-inch scope to the field and noticed right away, with some relief, that this would not be a problem with the NGC 4005 group.

A first glance at the area centered around the star SAO 82086 will most likely show 14th-magnitude **NGC 4005**, the brightest member of the group. This galaxy is bright enough that Otto Wilhelm Struve found it at Pulkovo Observatory. In the 31-inch scope at 225x, this spiral galaxy appeared to measure 3' by 3' and had a stellar nucleus. While the nucleus was immediately apparent because of its high surface brightness, that galaxy's nebulous outer envelope was visible only with averted vision.

Almost directly on the other side of the SAO 82086 is **NGC 4000**. This edge-on galaxy shines at 15th magnitude and spans 1' by 0.2'. NGC 4000 was very difficult to see because of the proximity of the 8.7-magnitude star. I needed patience and skillful use of averted vision to see this object. But once I saw it, NGC 4000 looked like a light feather against black, endless space.

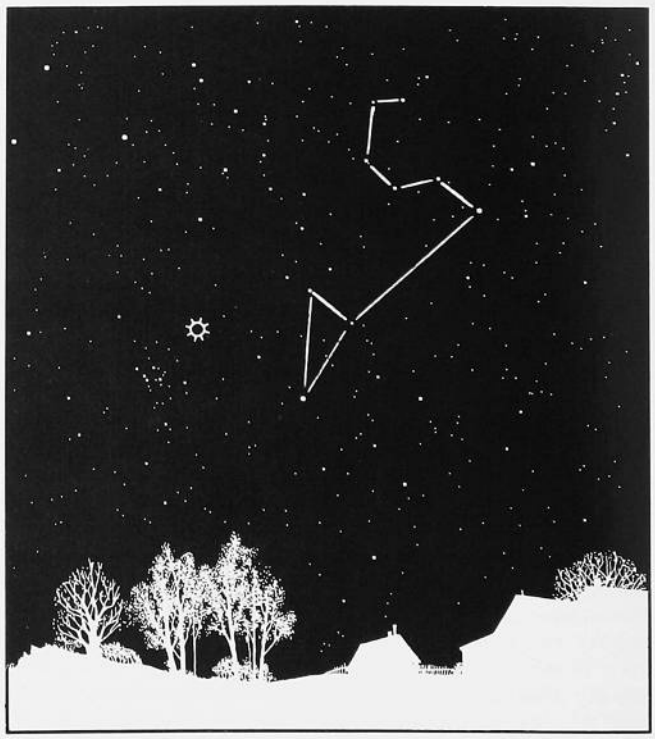
Probably the easiest galaxy in the group is **NGC 3997**. Apparently Sir William Herschel observed this galaxy on April 6, 1783, but it was not assigned a *General Catalogue* number. John Louis Emil Dreyer used a description of John Herschel's from 1833 for the *New General Catalogue*. This 14.5-magnitude galaxy showed more detail than any other object in the group. At 225x, NGC 3997 appeared mottled with a dark area running along its 2' length. The RNGC description calls it "elongated with brightening toward the middle."

Just 2' east of NGC 3997 lies **NGC 3993**, discovered by Lord Rosse with his 72-inch "Leviathon" at Birr Castle. In the 31-inch instrument this object resembled a faint version of M31 with a dim nucleus. While I estimated its magnitude at about 13 and thought it was easy to find, NGC 3993 has a photographic magnitude of 14.3. Perhaps this galaxy's high surface brightness makes it easy to see. The *RNGC* description for this object reads "edge on with equatorial dark lanes."

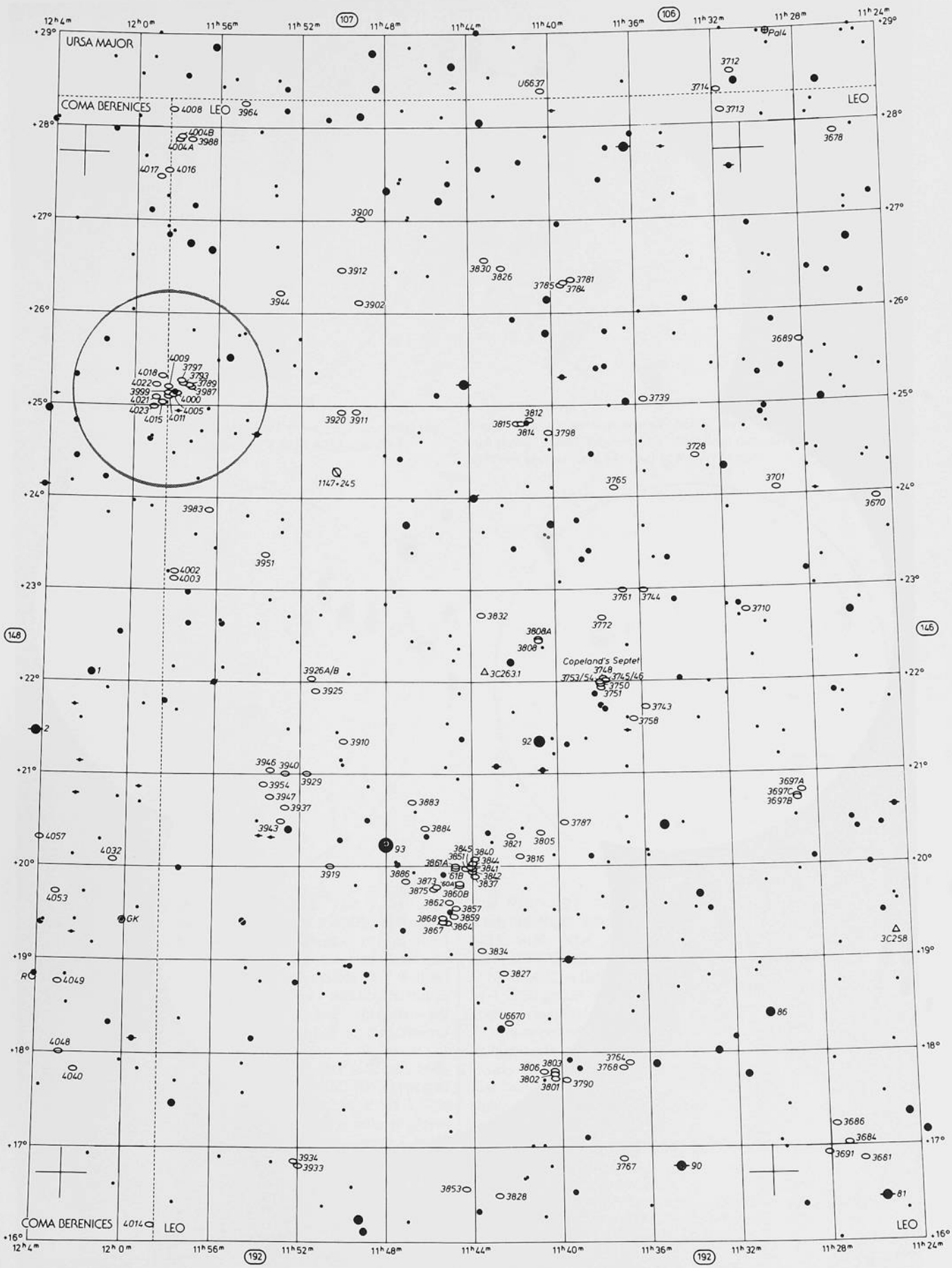
Two arcminutes east and slightly north lies a very challenging galaxy. **NGC 3987**, another Lord Rosse discovery, shines dimly at magnitude 14.5. Apparently this object has a low surface brightness, because I recorded seeing merely an oval fuzz. In stark contrast the Palomar photograph shows an edge-on, Sb galaxy with a well-defined dark lane.

The final galaxy in this section of the cluster is **NGC 3989**. This galaxy showed hints of structure across its elongated, 4'-by-0.5' shape. NGC 3989 is an impressive sight once found and observed with care. In the 31-inch telescope I thought I detected a dark lane across the galaxy's slightly mottled disk.

Sweeping back over NGC 4000 and NGC 4005, you will come across **NGC 3999** and **NGC 4011**. NGC 3999 is prob-



Above: A wide-field finder chart shows the rough position of the NGC 4005 galaxy group. Opposite page: A portion of Uranometria 2000.0 *plots the cluster's brightest galaxies. Copyright 1987 Willmann-Bell, Inc.*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COMA BERENICES
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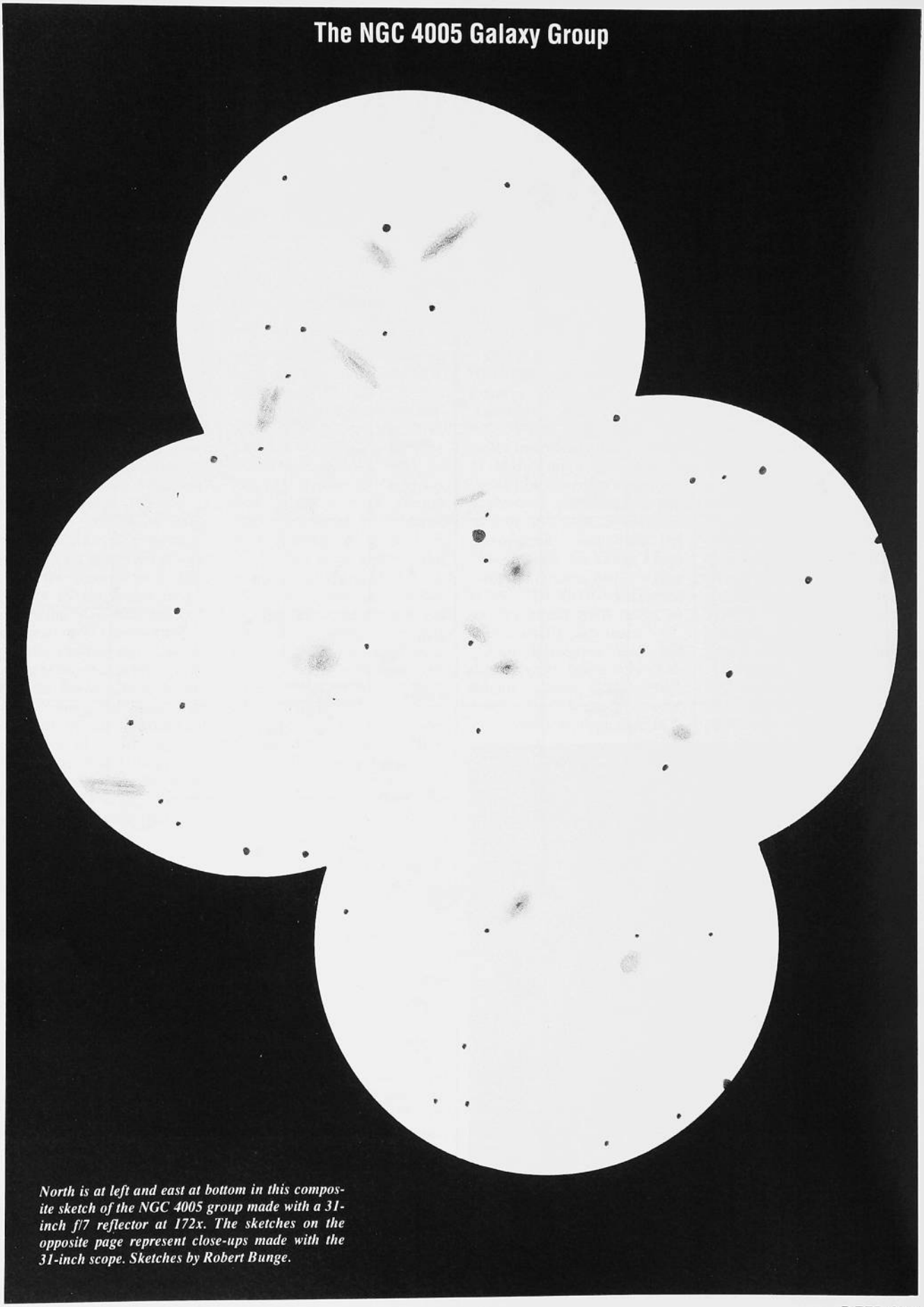
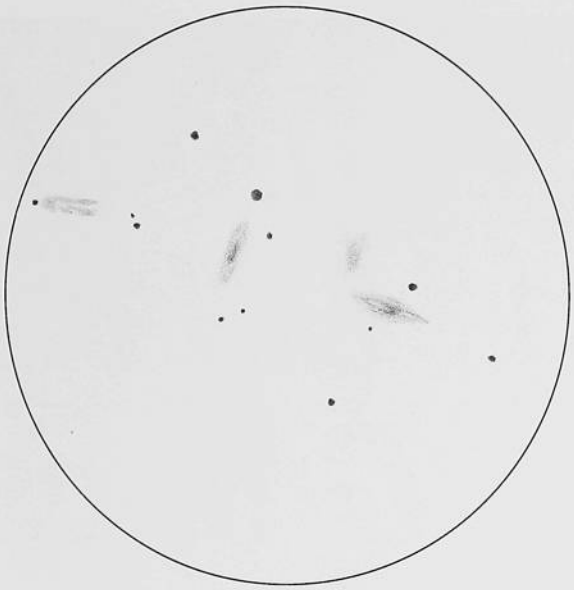
The NGC 4005 Galaxy Group

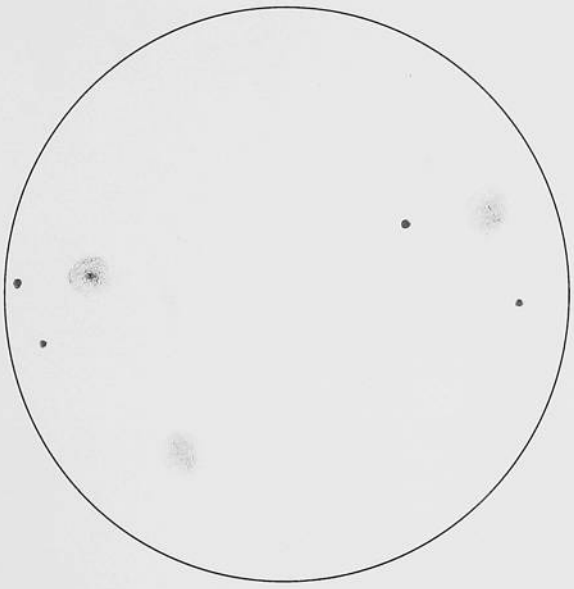


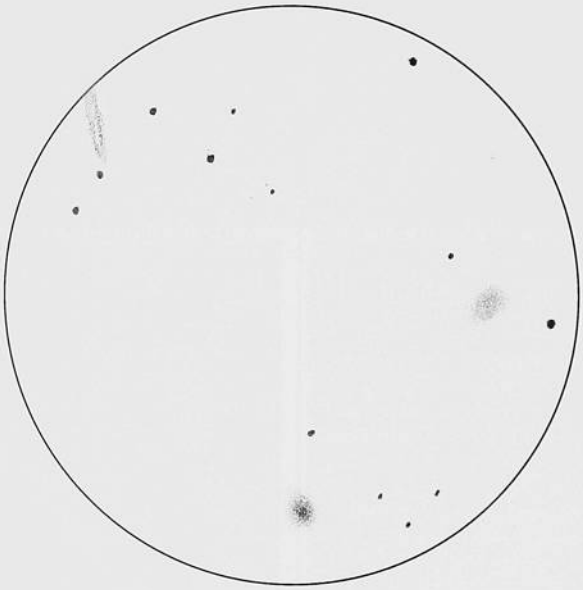
North is at left and east at bottom in this composite sketch of the NGC 4005 group made with a 31-inch f/7 reflector at 172x. The sketches on the opposite page represent close-ups made with the 31-inch scope. Sketches by Robert Bunge.



Above: This 13' field shows galaxies NGC 3997, 3993, 3987, and 3989 (left to right). Below: A similar field contains NGCs 4021, 4023, and 4015.

Above: A bright star accompanies NGCs 3999, 4005, and 4000 in this 31-inch sketch. Below: Edge-on NGC 4018, and fuzzballs NGC 4022 and 4009 dominate another field. Sketches by Robert Bunge.





ably the faintest galaxy in the entire group. The object measures 1' by 2' and was barely visible in the 31-inch scope. NGC 4011 was slightly brighter, but was also a tricky object. I first mistook this object for a star.

With NGC 4011 centered in the middle of my 20' field, I saw **NGC 4009** some 6' to the west. Even though the *RNGC* lists it at magnitude 14, this object's low surface brightness made it a challenge, although not as difficult as NGC 4011. NGC 4009 measured 3' in diameter, its shape almost perfectly round.

Recentering NGC 4011, I next moved out of Leo, crossed into Coma Berenices, and found **NGC 4015**. This galaxy was first recorded with Lord Rosse's 72-inch reflector. Dreyer noted in the *New General Catalogue* that it is possible that William Herschel saw this object. But as with NGC 3997, John Herschel did not list it in the *General Catalogue*.

In the 31-inch reflector, 14th-magnitude NGC 4015 appeared slightly elliptical, about 1.5' in diameter with a little brightening toward its center. I could not see any hint of the extended section that is described in the *RNGC* as a "peculiar object attached to the North."

Sweeping 3' northeast brought me to **NGC 4021**. There are two other galaxies near NGC 4021. Five minutes south of NGC 4021 is **NGC 4023**, while **NGC 4022** is 8' north of NGC 4021.

NGC 4022 is listed as a 1.3'-by-1.2' S0 galaxy with a photographic magnitude of 14.4. At 225x it appeared almost stellar; its high surface brightness made it easy to find. The only detail that NGC 4023 revealed was a sight brightening toward the center of its elliptical shape.

The final galaxy of this group is **NGC 4018**, 5' north of NGC 4022. NGC 4018 was a really nice slight in the 31-inch scope. This big edge-on galaxy clearly showed a dark lane, even though it is a dim object that requires averted vision to see. NGC 4018 has a photographic magnitude of 14.6.

Having made the grand tour of the NGC 4005 group, you will find the lineup of NGC 3997, NGC 3993, NGC 3987 and NGC 3989 about 1' west of NGC 4018.

It is fascinating that we can see these dim objects in backyard telescopes. Eleven of these galaxies were discovered with Lord Rosse's 72-inch scope, yet a modern 17.5-inch scope should reveal them to skilled observers.

It's likely that few people have seen these objects since they were discovered. Readers of *Deep Sky*, is it time to change that?

A Trio of Springtime Galaxy Groups

by Jeff Corder

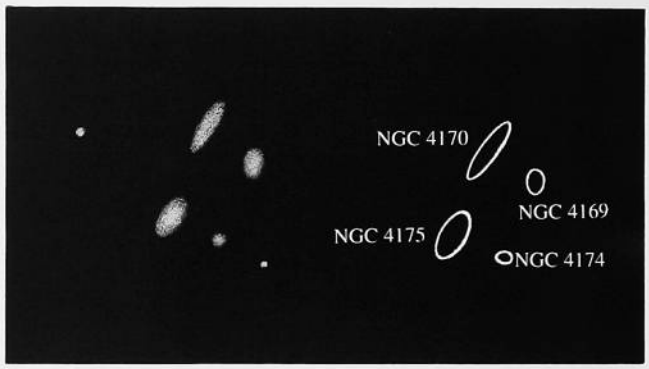
No two clusters of galaxies are exactly alike. Each clump of spirals and ellipticals in our night sky has its own individual character, its own unique makeup. Some clusters like Abell 2151 in Hercules are rich in spirals, while others contain relatively few spirals but many ellipticals, like the Perseus Galaxy Cluster, Abell 426. Others are classified as cD groups because they are dominated by a central cD galaxy. Such is the case with Abell 2199, the brightest member of which is the enormous cD galaxy NGC 6166. Still other galaxy groups, like the Virgo Cluster, appear to have an even distribution of members.

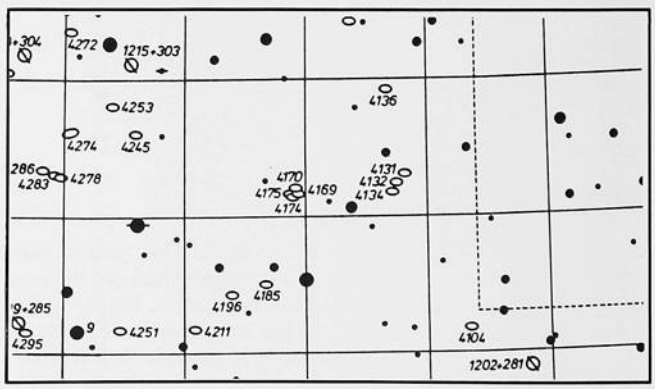
The accepted system relating galaxy groups is the Rood-Sastry classificatin scheme, developed by Herbert J. Rood of Princeton University and K. L. V. N. Sastry of Canada's University of New Brunswick. The Rood-Sastry system classifies galaxy clusters based on their visual and photographic appearances and differences in the distribution of indivudual members.

Fortunately springtime is the best time for viewing galaxy groups and clusters. Coma Berenices, Leo, and Virgo each contain heavy concentrations of galaxies. The Virgo Cluster, the most observed concentration of galaxies, is one of the brightest galaxy groups. However, its members are sparsely scattered over a large area, which make it appear not so much as a cluster but as a wide field of small galaxies covering many degrees of sky. Compare it with the region's rich clusters like the Coma Cluster or Abell 1367.

A few of springtime's galaxy groups are worth a detailed look. With today's large-aperture telescopes these groups hardly present a challenge to persistent observers. They do present new ground, unconquered territory for those who want to explore the limits of the galaxies they can observe. Three of these galaxy groups represent a particularly meaningful range over the Rood-Sastry scheme and offer plentiful challenges to backyard observers.

The **NGC 4169 group** contains only four bright members, all of which are visible in 8-inch or larger telescopes. To find this galaxy group, aim your telescope 3° west-northwest of Gamma Comae Berenices. You'll see a 6th-magnitude star accompanied by an 8th-magnitude star 10' to the northeast. (You may also see the faint galaxy NGC 4185 just south of the fainter star.) Place the cross hairs of your finder scope midway between these stars and slowly move the telescope 40' north. You are now centered on the NGC 4169 galaxy group.



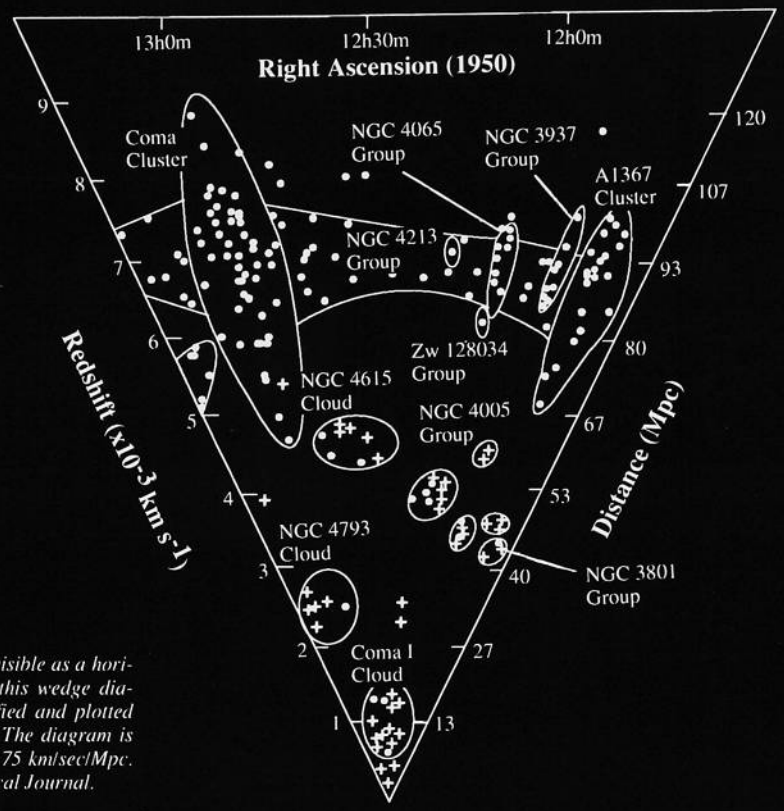


Top: This sketch of the NGC 4169 group has north at top and east at left; galaxies are identified at right. Jeff Corder recorded the group with a 12.5-inch f/6 reflector. Above: A portion of Uranometria 2000.0 *shows the position of the NGC 4169 group. Copyright 1987 Willmann-Bell, Inc.*

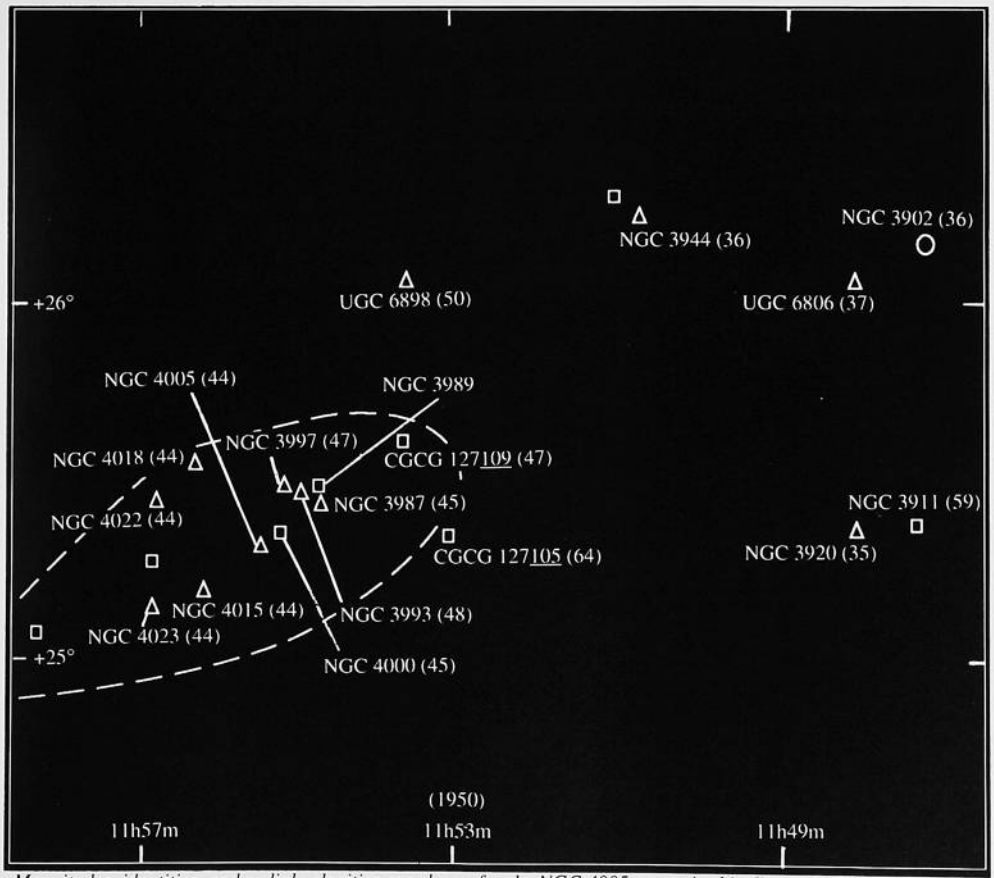
The NGC 4169 Galaxy Group

Galaxy	R.A.(2000.0)Dec.	Mag.	Size
NGC 4169	12h12.3m +29°11'	12.9	2.1' by 1.1'
NGC 4170	12h12.4m +29°13'	13.5?	—
NGC 4174	12h12.5m +29°09'	14.3	0.8' by 0.3'
NGC 4175	12h12.5m +29°10'	14.2	2.0' by 0.5'

A Slice of the Sky



The Coma-Virgo supercluster is visible as a horizontal bar across the center of this wedge diagram. Galaxy groups are identified and plotted by distance and right ascension. The diagram is based on the Hubble Constant at 75 km/sec/Mpc. After B.A. Williams in Astrophysical Journal.



Magnitudes, identities, and radial velocities are shown for the NGC 4005 group in this diagram after B.A. Williams. The outline of the cluster is indicated by a dashed line.

The Rood-Sastry Scheme (simplified)

cD. **Central-dominant.** Cluster is dominated by a single giant galaxy, often an elliptical, surrounded by a halo of dwarf galaxies.

B. **Binary.** Cluster is dominated by a pair of giant galaxies, usually ellipticals, surrounded by a halo of dwarf galaxies.

C. **Core-rich.** Cluster has a core of three or four large galaxies that are much brighter than other members.

L. **Line.** Dominant galaxies in the cluster are oriented in a chain or line (usually three or four galaxies).

F. **Flattened.** The cluster's few brightest members are evenly arranged and somewhat flattened.

I. **Irregular.** Cluster has an ill-defined symmetry, or its ten brightest members are randomly dispersed.

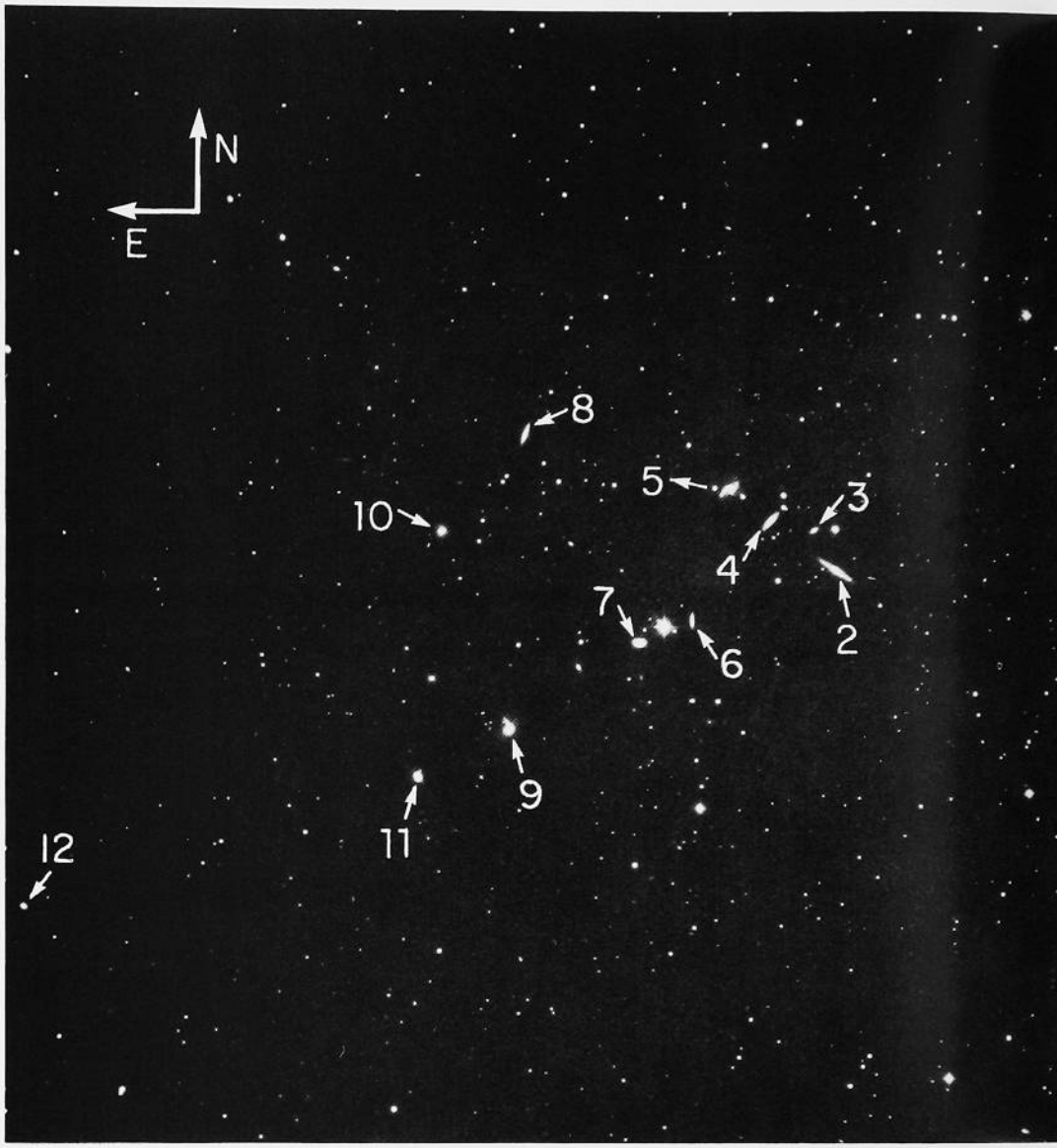
The galaxies in this group are arranged in a rectangular shape. **NGC 4169**, a lenticular galaxy with a photographic magnitude of 12.9, marks the rectangle's northwest corner. Although this galaxy's dimensions are 2.1' by 1.1', when I viewed it with a 12.5-inch telescope, NGC 4169 appeared to be a slightly asymmetrical fuzzball measuring 50" by 40" (oriented in p.a. 156°) with a bright nucleus. The rectangle's northeastern marker is the surprisingly faint galaxy **NGC 4170**. It is an edge-on galaxy with a low surface brightness. In my 12.5-inch scope, NGC 4170 measures 80" by 35" (in p.a. 160°) and contains a slightly brighter core.

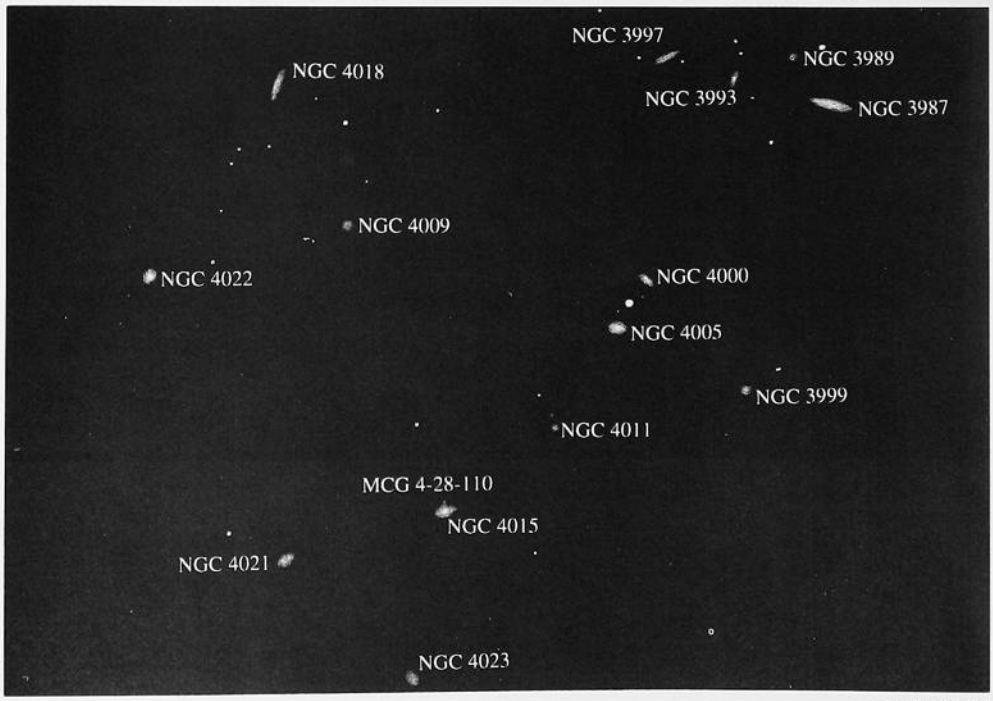
The southern half of the rectangle is made up of **NGC 4174**, an extremely small galaxy with a stellar nucleus, and **NGC 4175**, a lens-shaped galaxy. NGC 4174 is an object of unknown morphological type that glows dimly at photographic magnitude 14.9 and has an overall size of 0.8' by 0.3'. NGC 4175 is a spiral galaxy measuring 2.0' by 0.5' and glowing at photographic magnitude 14.2. Visually NGC 4175 measures 60" by 35" in p.a. 155°.

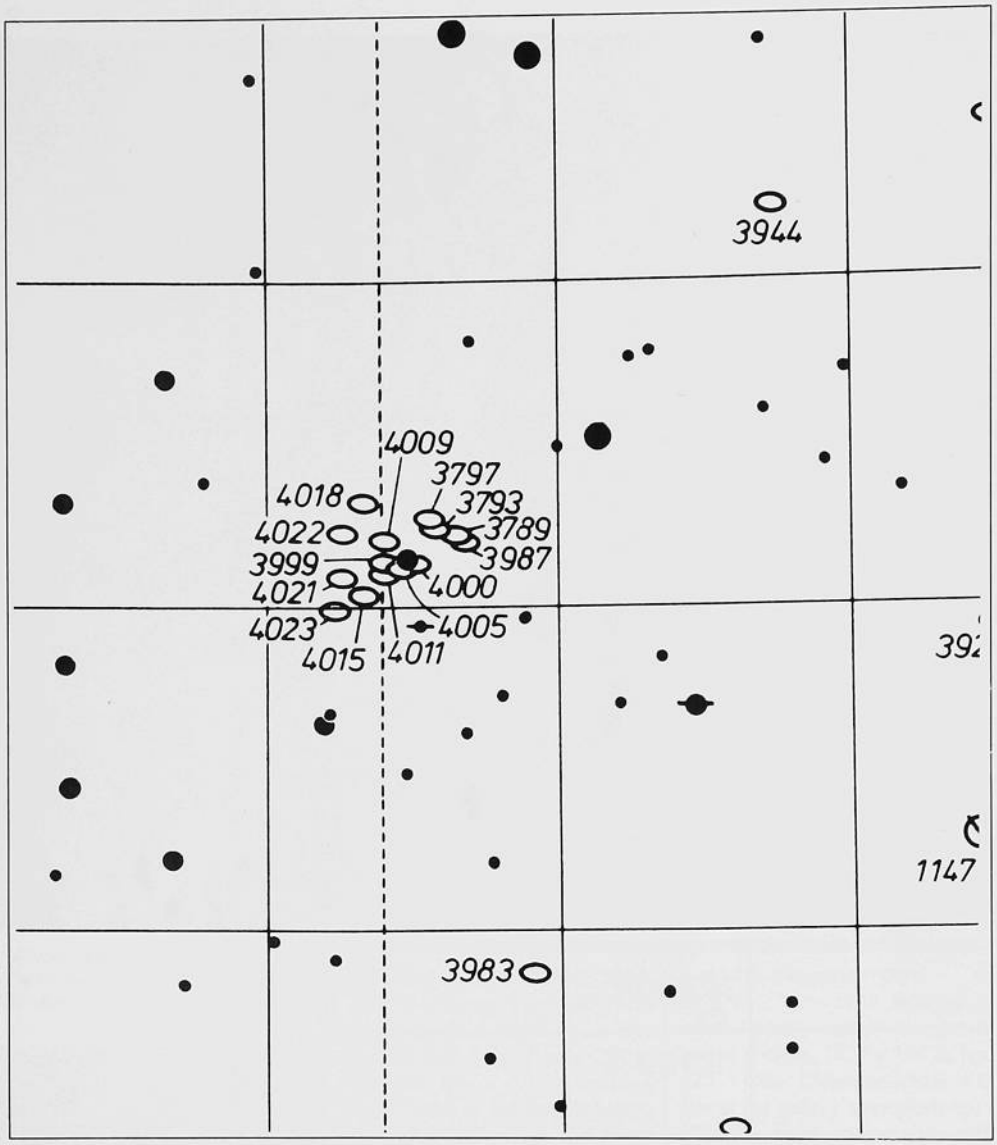
After you finish inspecting the four galaxies in the NGC 4169 group, swing your telescope 5° southwest. Here you'll find a rich clump of faint galaxies clustered around a solitary 8th-magnitude star. This is the **NGC 4005 galaxy group**. You'll be amazed at the contrast between this group and the previous one. The NGC 4005 group is much larger and richer, containing fourteen NGC galaxies in a diameter of 40'. The few brightest members can be glimpsed with an 8-inch telescope, but experience dictates that a 16-inch or 17.5-inch scope is necessary to spot the faintest ones.

The northwest end of the group contains the fine edge-on spiral galaxy **NGC 3987**. This object is the largest in the group, measuring 2.5' by 0.5', and glows at photographic magnitude 14.4. Tiny **NGC 3989**, a magnitude-15.7 galaxy measuring only 10" across, lies just east of NGC 3987.

Several arcminutes farther east lie the easier targets **NGC 3993** and **NGC 3997**. These



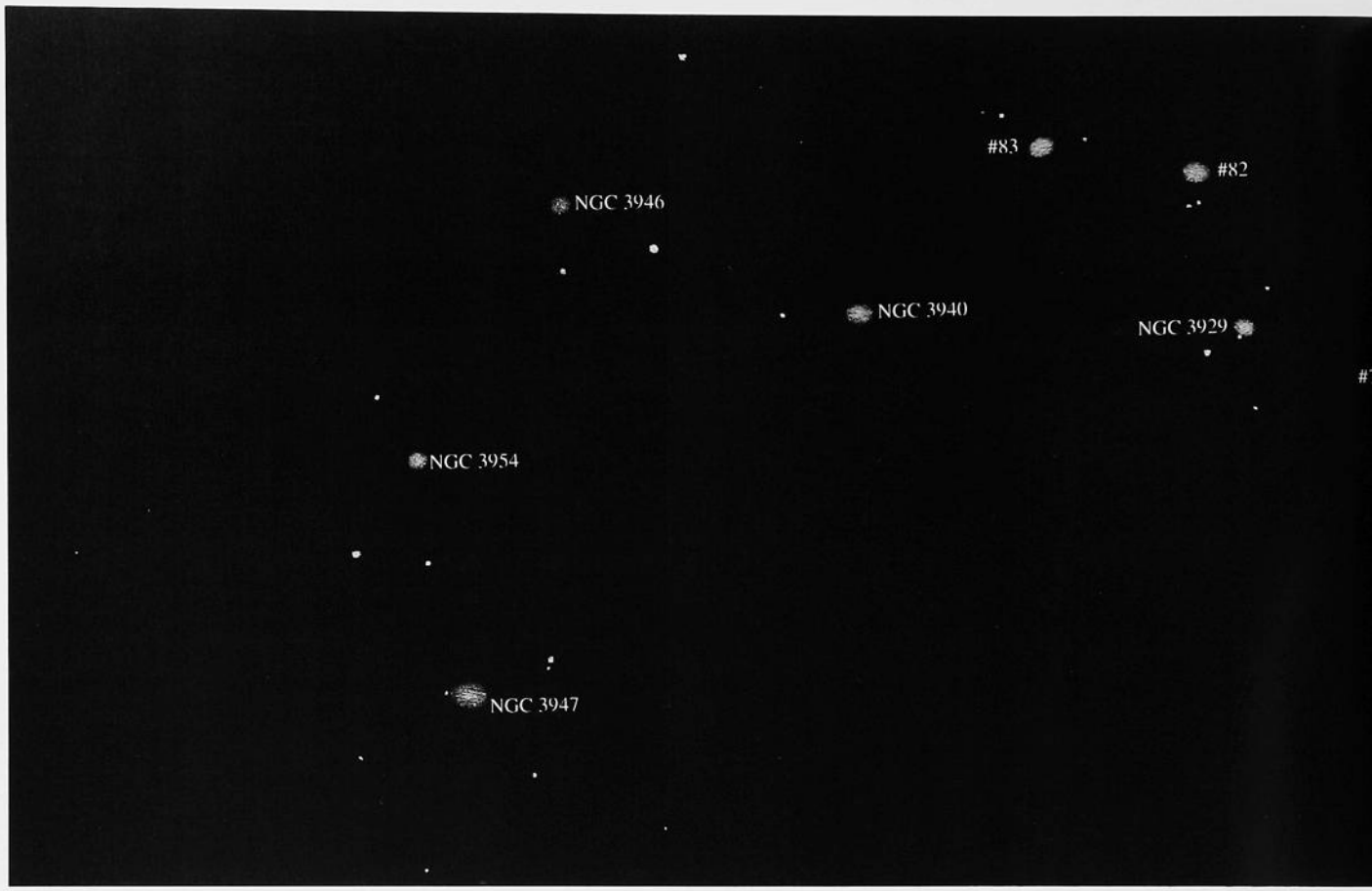


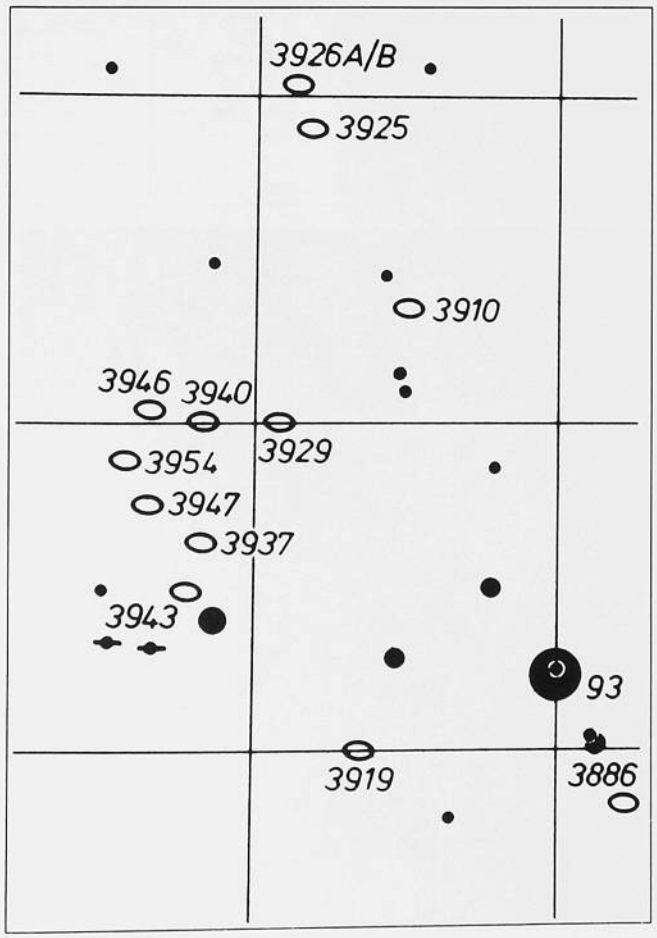


Left: The NGC 4005 group sketched by Jeff Corder using a 17.5-inch f/ 4.5 telescope. North is approximately at top and east to the left. Above: This photo of the NGC 4005 group is adapted from the blue plate of the Palomar Observatory Sky Survey. Labeled galaxies are: Zwicky 127-109 (1), NGC 3987 (2), NGC 3989 (3), NGC 3993 (4), NGC 3997 (5), NGC 4000 (6), NGC 4005 (7), NGC 4018 (8), NGC 4015A and NGC 4015B (9), NGC 4022 (10), NGC 4023 (11), and Zwicky 127-133 (12). From B.A. Williams, Astrophysical Journal. Above right: A finder chart from Uranometria 2000.0 *shows the cluster's bright members.* *Copyright 1987 Willmann-Bell, Inc.*

Bright Members of the NGC 4005 Galaxy Group

Galaxy	R.A.(2000.0)	Dec.	Mag.	Type	Size
NGC 3987	11h57.1m	25°11.6'	14.4	Sbc	2.3' by 0.4'
NGC 3989	11h57.1m	25°13.7'	15.7	Sbc	0.7' by 0.3'
NGC 3993	11h57.5m	25°14.4'	14.8	Sbc	1.6' by 0.4'
NGC 3997	11h57.6m	25°16.3'	14.3	S(B)bc	1.6' by 1.3'
NGC 3999	11h57.7m	25°05.3'	15.7	—	—
NGC 4000	11h57.7m	25°08.5'	15.2	Sc	1.1' by 0.2'
NGC 4005	11h57.9m	25°07.3'	14.1	Sb	1.1' by 0.6'
NGC 4009	11h58.1m	25°12.3'	—	—	—
NGC 4011	11h58.1m	25°05.6"	15.7	—	—
NGC 4015	11h58.7m	25°02.3'	14.2	—	0.8' by 0.2'
MCG428110	11h58.7m	25°02.3'	15.7	Pec	—
NGC 4018	11h58.7m	25°18.8'	14.7	Sc	1.8' by 0.3'
NGC 4021	11h58.8m	25°04.7'	15.3	—	—
NGC 4022	11h58.8m	25°13.3'	14.4	S0	1.3' by 1.2'
NGC 4023	11h58.8m	24°59.3'	14.6	Sb	1.1' by 0.7'

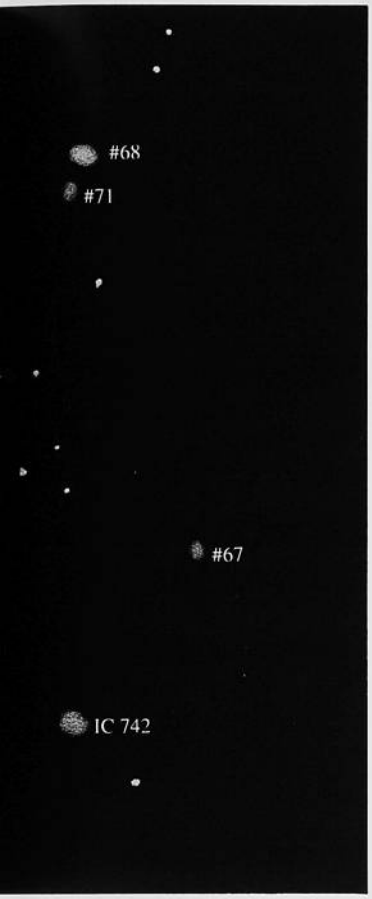




Above: Jeff Corder sketched the NGC 3937 galaxy group using a 17.5-inch f/4.5 reflector. The finder chart, from Uranometria 2000.0, shows major galaxies in the cluster. Copyright 1987 Willmann-Bell, Inc.

Fundamental Data for the NGC 3937 Galaxy Group

Galaxy	R.A. (2000.0)	Dec.	Mag.	Type
#67	11h50.6m	20°54.4'	15.5	E1
#68	11h50.7m	21°09.7'	15.3	—
#70	11h50.7m	20°29.6'	15.4	E1
#71	11h50.7m	21°08.5'	15.4	—
#72	11h50.8m	20°23.7'	14.6	S pec
IC 742	11h50.8m	20°47.7'	15.1	—
#74	11h50.9m	20°59.7'	15.0	E1
NGC 3929	11h51.7m	20°59.8'	14.5	E1
#82	11h51.7m	21°06.5'	14.7	S pec
#83	11h52.1m	21°05.7'	15.1	—
IC 2968	11h52.5m	20°37.4'	15.5	—
NGC 3937	11h52.7m	20°37.6'	14.0	E1
NGC 3940	11h52.7m	20°59.3'	14.3	E1
NGC 3943	11h52.7m	20°28.5'	14.7	—
#92	11h52.9m	20°39.4'	15.3	E1
NGC 3947	11h53.1m	20°44.8'	14.2	S pec
NGC 3946	11h53.1m	21°01.3'	15.5	—
NGC 3954	11h53.7m	20°52.7'	14.4	E1
#100	11h53.9m	20°34.3'	14.9	—



galaxies are nearly twins: both appear to be nearly edge-on and have a lenticular shape. NGC 3993 is an Sb-type spiral glowing at photographic magnitude 14.8 and spanning some 1.9' by 0.6'. In the 12.5-inch scope this galaxy appears to measure 75" by 20" in p.a. 110°, and it shows a very faint nucleus. NGC 3997 is a peculiar, barred spiral with a photographic magnitude of 14.3 and a diameter of 1.8' by 1.0'. Visually this object can be seen lying between two faint stars and measures 80" by 25" in p.a. 100°. Some 15' east lies another edge-on spiral, **NGC 4018**. This object also has a lenticular appearance and is relatively faint with the 12.5-inch scope. It measures 100" by 25" in p.a. 115°.

As you move southward, **NGC 4022** pops into view. NGC 4022 is a face-on lenticular galaxy that dimly glows at photographic magnitude 14.4 and spans 30". The most noticeable observational characteristic of NGC 4022 is its prominent condensed nucleus. Extremely faint **NGC 4009** can be glimpsed 10' to the west. This one requires a sharp eye and clean optics, and even then averted vision will show it best. It appears slightly oval and seems to be about 20" in diameter.

The brightest galaxy in this cluster is **NGC 4005** itself, an Sb-type system lying near the central 8th-magnitude star. NGC 4005 covers 45" by 30" of sky as seen in the 12.5-inch scope. It contains a faint nucleus and is elongated in p.a. 65°. **NGC 4000**, lying directly on the other side of the 8th-magnitude star, is a 15th-magnitude spiral that appears nearly edge-on. NGC 4000 measures 50" by 20" and is evenly illuminated across its surface.

Galaxies **NGC 3999** and **NGC 4011** lie closeby, just to the south. Each of these objects is an extremely faint, round smudge of light. A 16-inch telescope provides a glimpse of these gaalaxies, but don't expect to see much detail. Both galaxies have a photographic magnitude of 15.7 and measure less than 15" across.

A trio of easier galaxies lies 15' southeast. A probable elliptical, **NGC 4015** is the brightest of the three. Upon close inspection at high powers, NGC 4015 appears to have a faint, peculiar companion attached to its northern end. NGC 4015 has a bright nucleus and is reasonably large, measuring 50" by 35" in p.a. 75°. **NGC 4023** lies 8' southeast of NGC 4015. NGC 4023 is quite faint and covers 40" by 30" in size. **NGC 4021**, the trio's third component, is similar. It glows at photographic magnitude 15.3, spans 40" by 25", and is oriented almost exactly east-west.

The third grand galaxy group we'll look at this spring lies just over 1° northeast of the bright star 93 Leonis. The **NGC 3937 galaxy group** appears to be a small component of the Coma-Virgo Supercluster, along with such company as Abell 1367 and the Coma Cluster of galaxies. (Each of these magnificent clusters was described in *Deep Sky* 10, Spring 1985.) Seven members of the NGC 3937 group belong to the *NGC*, most of which are positioned along a curving string.

NGC 3937, the brightest object in the group, glows at photographic magnitude 14.0. NGC 3937 is visible in an 8-inch telescope on dark nights with a little effort, when it appears faint, small, and slightly elongated in p.a. 80°. The extremely faint and small galaxy **IC 2968** lies some 90" to the west.

NGC 3943 is located 5' northeast of a prominent 6th-magnitude star at the southern edge of the group. NGC 3943 is a faint, small, round galaxy only 25" in diameter. Fourteenth-magnitude **NGC 3947** can be spotted a little over 15' to the northeast. This 40"-by-35" spiral appears faint but contains a small, bright core. On extremely steady nights you may see a 16th-magnitude star at its eastern tip.

Galaxy groups present new ground, unconquered territory for those who want to explore the limits of the galaxies they can observe.

To the north is **NGC 3954**. This 14.4-magnitude elliptical galaxy is very small, faint, and exactly round. It is only 25" in size and has a bright nucleus. **NGC 3946** is 10' farther north. It is extremely faint and small even in a 17-inch telescope. Little detail can be detected of this 10"-diameter galaxy.

The bright elliptical galaxy **NGC 3940** is about 8' to the west. It shines at the equivalent brightness of a magnitude 14.3 star. It is 35" by 30" in size, contains a fairly bright core, and is oriented due east-west. **NGC 3929** precedes it by 10' to 12'. This 14th-magnitude elliptical galaxy appears very small and compact. It measures only 30" by 25" in size and contains a bright center. A magnitude-16 star is seemingly attached to its southern side.

The NGC 3937 group is a good hunting ground for anonymous galaxies. The following are telescopic descriptions of a few of the brighter ones using a 17.5-inch Newtonian telescope:

1. *#67.* Extremely faint and small, slightly elongated, 15" by 12" in p.a. 0°.
2. *#68.* Extremely faint, very small, slightly elongated, bright middle, diffuse, 35" by 30" in p.a. 90°.
3. *#71.* Extremely faint, extremely small, 15" by 12".
4. *#74.* Faint, very small, little elongated, pretty bright middle, 25" by 20" in p.a. 80°.
5. *#82.* Faint, small, almost round, gradually brighter to the middle, 25" by 20" in p.a. 100°. Two 16th-magnitude stars nearby.
6. *#73.* IC 742: Faint, pretty small, diffuse, faint middle, 45" diameter.
7. *#83.* Faint, small, slightly elongated, faint core, 25" by 20" in p.a. 110°.
8. *#72.* Very faint, small, little elongated, faint core, p.a. 90°, 25" by 20" in p.a. 90°. Between two 14th-magnitude stars.
9. *#70.* Very faint, extremely small, pretty much elongated, bright middle, 20" by 10" in p.a. 125°. One 15th-magnitude star lies at the galaxy's northern tip.
10. *#92.* Faint, extremely small, round, bright core, 12" in diameter.
11. *#100.* Faint, small, slightly elongated, pretty bright middle, 30" by 25" in p.a. 50°.

Rood and Sastry would say that each of these galaxy groups is very different. The NGC 4169 group is small and very poor, curiously arranged in a rectangle. The NGC 4005 group contains a large number of edge-on spirals and is loosely spread out in no easily interpreted pattern. The NGC 3937 group strings along a curving line. Most of its members are ellipticals. What can you determine about any of these groups or galaxy clusters overall from your observations of three galaxy groups this spring?

Jeff Corder lives in Tice, Florida, and specializes in observing galaxies.

The Messier Marathon: A One-Night Stand

by Tom and Lynn Hoffelder

Near the first day of spring most of the Messier objects can be seen during the course of a single night. This challenge, known as the Messier Marathon, does not allow time for a detailed study of the objects; however, it is a unique project that improves locating skills. The Marathon is possible because none of the objects lies near the Sun at this time of the year.

Because setting circles and CATs are not allowed in true Messier Marathons, the right-angle sweep is the easiest way to locate more than one hundred objects in one dusk-to-dawn period. This method utilizes sweep distances and directions for each object from an easily identifiable star that lies nearby or from the object previously located. After the appropriate star is centered in the eyepiece, the telescope is moved north or south, then east or west, the required distances. (While an equatorial mount is recommended, these movements can be approximated on altazimuth mounts with good results.) The distances are measured by observing background stars as they cross the field of view, so the sweep is simplified by the use of a 1° true-field eyepiece. A detailed description of the right-angle sweep can be found in the Winter 1987 issue of *Deep Sky*.

The Messier objects are presented here in order of the search, along with the necessary sweep information and basic object descriptions. To begin, start looking for M74 as soon as Eta Piscium becomes visible, and then proceed eastward through the sky, object by object, until dawn arrives. About one hundred of the objects can be located with little difficulty. Of those remaining, M2, M33, M55, M72, M73, M74, M75, and M77 can be somewhat of a problem and M30 is considered practically impossible.

A little practice and planning prior to a marathon attempt can make a big difference in the results. If the right-angle sweep is to be used, a review of the required stars' locations will be helpful. When packing for the marathon, take loads of munchies and your favorite source of caffeine. Also take plenty of warm clothing — clear March nights can get very cold, even in the southern United States. (Last year in Oklahoma the wind-chill factor hovered near 0° F the entire night.) Be prepared with a supply of spare flashlight batteries and bring a watch to record the sighting time of each object. Most important is the selection of an observing site. Unobstructed west and southeast horizons are a necessity.

We are now ready to run a Messier Marathon. On a clear, moonless night near March 20 we arrive at our observing site just after sunset and set up the telescope. As soon as the north star appears, the polar axis is pointed in its direction. Alignment within 1° of the celestial pole is close enough for the right-angle sweep. Now we can relax, probably our last chance for a while, until the glow of dusk begins to disappear in the west.

The first stars to be seen there will be Alpha and Beta Arietis, which point toward the lower and dimmer Eta Piscium, the sweep star for M74. Finding this dim galaxy can be a real challenge, because not only do lingering twilight and low altitude create poor visibility, but the zodiacal light, brightest in March, covers the area. Because it is difficult to determine when the best seeing conditions occur for M74, the search must begin as soon as Eta Piscium is sighted and be continued until the object is hopefully glimpsed. However, we cannot spend so much time on it that other westerly objects are lost. Missing M74 is no cause for despair; it is only one object and the next one hundred or so are not as difficult.

Above: M74 is typically the first object to find in a Messier Marathon. Photo by Kim Zussman (11-inch f/10 SCT, hypered Tech Pan film, 120-minute exposure).
Inset: M77 is a difficult object to catch in the marathon. Photo by Kim Zussman (11-inch f/10 SCT, hypered Tech Pan film, 105-minute exposure).

After logging the time for M74, if seen, we proceed to the other galaxies scattered along the western horizon. We jump into the winter Milky Way with its clusters and nebulae. This includes everything from M52 to M67, all of which are bright and easily located. This is downhill cruising, so enjoy!

With M67 behind us, we have reached the first natural break in the marathon. There should be about an hour to relax. Now is the time to give your body a hefty shot of sugar and caffeine before starting to track down the thirty-four spring galaxies.

High-density areas, such as the Coma-Virgo Cluster, are where the right-angle sweep really shines. It is simply a matter of sweeping from one object

A MESSIER MARATHON SWEEP LIST

M#	From	Sweep	Type	Mag.	Size
74	eta Psc	0.4°N, 1.3°E	gal	10.5	10'x9'
77	delta Cet	0.3°S, 0.8°E	gal	10.5	6'x5'
33	alpha tri	1.0°N, 4.0°W	gal	7.0	65'x35'
31	mu And	2.8°N, 2.6°W	gal	4.5	160'x35'
32	M31	0.4°S	gal	10.0	3'
110	M31	0.4°N, 0.4°W	gal	10.0	10'x4'
52	beta Cas	2.4°N, 5.1°W	oc	8.0	12'
103	delta Cas	0.5°N, 1.0°E	oc	7.0	5'
76	phi Per	1.0°N	pn	12.0	2'x1'
34	gamma And	0.4°N, 6.9°E	oc	6.0	20'
45	—	Pleiades	oc	—	—
79	beta Lep	3.8°S, 0.96°W	gc	8.5	3'
42	theta Ori	—	dn	—	60'
43	M42	0.1°N	dn	—	20'x15'
78	zeta Ori	2.0°N, 1.5°E	dn	—	8'x6'
1	zeta Tau	0.9°N, 0.7°W	snr	8.5	6'x4'
37	theta Aur	4.7°S, 1.6°W	oc	6.0	20'
36	M37	1.6°N, 3.2°W	oc	6.5	12'
38	M36	1.7°N, 1.5°W	oc	7.0	20'
35	1 Gem	1.1°N, 1.1°E	oc	5.5	40'
41	alpha CM	4.0°S, 0.4°E	oc	5.0	30'
50	theta CMa	3.7°N, 2.1°E	oc	7.0	16'
47	gamma CMa	1.2°N, 8.0°E	oc	4.5	25'
46	M47	0.4°S, 1.1°E	oc	6.5	25'
93	xi Pup	1.0°N, 1.1°W	oc	6.5	25'
48	zeta Mon	2.8°S, 1.6°E	oc	5.5	30'
44	delta Cnc	1.6°N, 1.0°W	oc	4.0	95'
67	alpha Cnc	0.1°S, 1.8°W	oc	7.5	15'
81	h UMa	6.0°N, 2.2°E	gal	8.5	20'x10'
82	M81	0.6°N, 0.1°E	gal	9.5	9'x4'
108	beta Uma	0.7°S, 1.4°E	gal	11.0	8'x1'
97	M108	0.7°S, 0.4°E	pn	12.0	3'
109	gamma UMa	0.3°S, 0.6°E	gal	11.0	6'x3'
106	chi UMa	0.5°S, 5.6°E	gal	9.5	19'x7'
40	delta UMa	1.2°N, 2.6°E	ds	9, 9.3	50" sep.
95	alpha Leo	0.2°S, 8.7°W	gal	11.0	6'x4'
96	M95	0.1°N, 0.7°E	gal	10.5	5'x4'
105	M96	0.7°N, 0.2°E	gal	11.0	2'
65	theta Leo	2.3°S, 1.2°E	gal	10.5	7'x1'
66	M65	0.1°S, 0.3°E	gal	10.0	8'x2'
51	eta UMA	2.1°S, 3.0°W	gal	10.0	10'x5'
63	M51	5.2°S, 2.7°W	gal	10.0	10'x5'
101	eta UMa	5.0°N, 2.3°E	gal	8.5	20'
94	alpha CVn	2.8°N, 1.0°W	gal	9.5	5X3'
3	beta Com	0.5°N, 6.6°E	gc	7.0	10'
53	alpha Com	0.6°N, 0.7°E	gc	8.5	3'
64	alpha Com	4.2°N, 3.1°W	gal	9.0	6'x3'
98	beta Leo	0.3°N, 6.0°E	gal	11.0	8'x2'
99	M98	0.5°S, 1.2°E	gal	10.5	4'
100	M99	1.4°N, 1.0°E	gal	10.5	5'x4'
85	M100	2.4°N, 0.5°E	gal	10.5	2'
84	omic Vir	4.2°N, 4.8°E	gal	11.0	1'
86	M84	0.3°E	gal	11.0	2'x1'
88	M86	1.5°N, 1.5°E	gal	11.0	5'x2'
91	M88	0.1°N, 0.8°E	gal	11.5	4'x3'
49	omic Vir	0.7°S, 6.1°E	gal	10.0	2'x1'
60	epsi Vir	0.6°N, 4.5°W	gal	10.5	2'
59	M60	0.1°N, 0.4°W	gal	11.5	2'x1'
58	M59	0.2°N, 1.1°W	gal	11.0	4'x3'
87	M58	0.6°N, 1.6°W	gal	11.0	2'
89	M87	0.2°N, 1.2°E	gal	11.5	1'
90	M89	0.6°N, 0.3°E	gal	11.0	7'x2'
61	eta Vir	5.1°N, 0.5°E	gal	10.5	5'
104	eta Vir	4.6°N, 1.9°E	gal	9.5	6'x2'
68	beta Crv	3.4°S, 1.2°E	gc	9.0	3'
83	pi Hya	3.2°S, 6.3°W	gal	8.5	10'x8'
102	iota Dra	3.2°S, 2.6°W	gal	11.5	2'x1'
5	alpha Ser	4.3°S, 6.4°W	gc	7.0	12'
13	eta Her	2.5°S, 0.2°W	gc	7.0	10'
92	pi Her	6.3°N, 0.4°E	gc	7.5	8'
12	delta Oph	1.7°N, 8.2°E	gc	8.0	9'
10	M12	2.3°S, 2.4°E	gc	7.5	8'
107	zeta Oph	2.5°S, 1.2°W	gc	10.0	2'
80	delta Sco	0.4°S, 3.9°E	gc	8.5	3'
4	alpha Sco	0.1°S, 1.3°W	gc	7.5	14'
14	beta Oph	7.8°S, 1.5°W	gc	9.5	3'
9	eta Oph	2.8°S, 2.1°E	gc	9.0	2'
19	alpha Sco	0.2°N, 7.5°E	gc	8.5	4'
62	M19	3.8°S, 0.3°W	gc	8.0	4'
57	beta Lyr	0.3°S, 0.8°E	pn	9.5	1'
56	beta Cyg	2.2°N, 3.0°W	gc	9.5	1'
29	gamma Cyg	1.7°S, 0.3°E	oc	9.0	12'
30	alpha Cyg	3.2°N, 8.5°E	oc	5.5	30'
27	gamma Sge	3.2°N, 0.2°E	pn	7.5	8'x4'
71	gamma Sge	0.7°S, 1.2°W	gc	8.5	6'
11	beta Sct	1.5°S, 1.0°E	oc	7.0	10'
26	M11	3.2°S, 1.5°W	oc	9.5	9'
16	gamma Sct	0.8°N, 2.5°W	dn	—	20'
17	gamma Sct	1.5°S, 2.0°W	dn	—	20'x10'
18	M17	1.0°S, 0.2°W	oc	8.0	12'
24	M18	1.2°S, 0.7°W	oc	11.5	4'
23	M24	0.5°S, 5.1°W	oc	6.0	25'
25	gamma Sct	4.7°S, 0.6°E	oc	6.5	40'
7	lambd Sco	2.3°N, 4.3°E	oc	3.5	60'
6	M7	2.6°N, 2.9°W	oc	4.5	25'
28	lambd Sgr	0.6°N, 0.7°W	gc	8.5	5'
8	M28	0.6°N, 4.6°W	dn	—	60'x35'
20	M8	1.3°N, 0.6°W	dn	—	20'
21	M20	0.5°N, 0.7°E	oc	7.0	10'
22	gamma Sgr	1.5°N, 1.9°E	gc	6.5	17'
69	epsil Sgr	2.0°N, 1.5°E	gc	9.0	3'
70	M69	2.7°E	gc	9.0	2'
54	M70	1.0°N, 2.6°E	gc	8.5	2'
55	zeta Sgr	1.1°S, 8.1°E	gc	7.0	10'
15	epsil Peg	2.3°N, 3.5°W	gc	7.5	7'
75	beta Cap	7.1°S, 3.5°W	gc	9.5	2'
72	epsil Aqr	3.0°S, 1.4°E	gc	10.0	2'
73	M72	0.1°S, 1.4°E	oc	9.0	—
2	beta Aqr	4.0°N, 0.5°E	gc	7.5	8'
30	gamma Cap	6.5°S	gc	8.5	6'

to another. A good example starts with M60, which is 0.6° north and 4.5° west of Epsilon Virginis. From M60 we can sweep 0.1° north and 0.4° west to M59, then on to M58, M87, M89, and finally to M90. Within five minutes or less, six galaxies have been located and positively identified.

The heavens wheel by until 02:15 is logged beside M102, the final galaxy. And it's a good thing, because we're getting a little tired of dim, fuzzy spots. Knowing that the remaining targets reside in the Milky Way is a bit of a relief. Now past the halfway mark, the second break in the marathon arrives and it is time for more food and drink. But we can afford only a brief pause before getting back to the race full steam ahead.

A group of a dozen globulars comprise the next section of the course. Beginning with M5 and ending with M62, these are all larger and brighter than many of the galaxies found earlier. The globulars will provide a needed chance to catch our breath because, once they're found, we begin a dash down the summer Milky Way.

Starting in Cygnus and ending in richly populated Sagittarius, this last effort could be dubbed the "Heartbreak Hill" of the Messier Marathon. Most of the objects are bright and easily located under normal conditions, but the clock now reads somewhere around 3 a.m. We are probably not quite as sharp as we were seven-and-a-half hours earlier, and the Milky Way contains twenty-five objects that must be found before twilight interferes. It has become a race against the Sun.

But it's a race that can be won, and we suddenly find ourselves viewing M55 with time to spare. Locating as many as possible of the final half-dozen objects low in the southeast is all that remains of the marathon. When daybreak ends the possibility of further observation, anyone who has searched through the entire night is a marathon finisher. Those who have located more than one hundred objects on the famous list can consider themselves winners.

A bit wobbly, we sit and watch the sunrise. We are cold and tired and our stomachs are complaining. Then we notice the damp, crumpled sheets of paper with their scribbled time entries and realize we have just seen nearly all of the objects that took Charles Messier twenty-three years to catalogue. Basking in the glow of our achievement, the discomfort is forgotten as we load our equipment and drive safely home to a good day's sleep.

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Deep Sky Reports
Spring's Challenging Deep-Sky Objects
by Phil Harrington

"The hobby of amateur astronomy generates lots of people who spend a great deal of time under the stars but never share their comments or observations with their fellow observers. And I'd like to do something about it." So wrote Steve Coe, an avid observer who lives in Glendale, Arizona. At about the same time New York contributor Phil Harrington lamented the same thing. Each submitted descriptions of some of their favorite challenging objects. You, dear reader, are invited to send observations of these objects for publication in the next issue of Deep Sky. *We want to hear from as many people as possible, with as great a range of instruments and experience as we can. — DJE.*

The Ursa Major Moving Cluster: A Naked-Eye Challenge

Stats: Open star cluster. Position: 12h03m, +58° (2000). Mv: 0.4. Size: 1400'.

All of us undoubtedly first heard of the Big Dipper as children. We learned, somewhat erroneously, that this "constellation" is the easiest one in the sky to recognize. You might recall seeing a diagram that is still included in most elementary science and astronomy books today. It shows the relative positions of the Dipper stars as they currently are and as they will appear in many thousands of years. Over that stretch of time the familiar bowl-and-handle pattern will be lost, but five of the stars will still move with a common proper motion.

The stars' shared movement through space was first suspected by R. A. Proctor in 1869 and confirmed three years later by William Huggins. Modern studies conclude that at least sixteen stars belong to this sparsely populated cluster. The group lies about 23 parsecs away and spreads across a volume of about 5 by 10 parsecs. The group covers a diameter of some 23° on our sky. A dozen of these stars are brighter than 6th magnitude and are therefore visible to the naked eye on clear nights.

A Binocular Challenge: M51 and NGC 5195

Stats: Pair of interacting galaxies. Position (M51): 13h29.9m, +47°12'. Mv: 8.4 and 9.6. Sizes: 11.0' by 7.8' and 5.4' by 4.3'.

Binoculars are not known as useful instruments for picking out galaxies, yet they do an admirable job of revealing the brightest and largest galaxies. One of the most challenging targets for binoculars is the Whirlpool Galaxy, M51. Look for its 8th-magnitude glow within a trapezoid of 7th-magnitude stars about 3.5° south of Alkaid, the end star in the Big Dipper's handle.

M51 is the classic face-on Sc spiral. Charles Messier discovered it in October 1773, and it has since become a favorite of telescopic galaxy hunters. M51's spiral form was first noticed by Lord Rosse in 1845 with the mammoth, 72-inch "Leviathon of Parsontown." Today's 6-inch or 8-inch reflector reveals the galaxy's spiral pattern under steady skies.

Seven-power binoculars show M51 as a small, circular patch of light surrounding a faint, starlike center. Look carefully for a subtle protrusion on the galaxy's northern edge — that is NGC 5195, the Whirlpool's companion galaxy. The little galaxy is passing M51, drawing material from it through its gravitational tug. Can binoculars show evidence of interaction between galaxies?

Hunting the Ghost of Jupiter with a 2-inch Telescope

Stats: Planetary nebula. Position: 10h24.8m, -18°38'. Mv: 8.6 (photographic). Mv°: 12.0. Size: 16"/1250".

Hydra is famous for being the longest constellation in the sky. About a third of the way between the serpent's head and its tail lies NGC 3242, a planetary nebula known as the "Ghost of Jupiter." (Admiral Smyth, the nineteenth-century English observer, believed this object resembled Jupiter in his telescope.)

To locate NGC 3242, look 2° south and a little west of Mu Hydrae. Your 2-inch telescope will show the Ghost as a small, pale gray disk close to 10" across. You'll need to use high magnification on a night of steady seeing to identify the Ghost as anything more than a bloated star. You may see the object's 12th-magnitude central star as a faint dot in the nebula's center if the atmosphere is exceptionally clear.

Six- or Eight-inch Scopes Focus on NGC 4361

Stats: Planetary nebula. Position: 12h24.5m, -18°48'. Mv: 10.3 (photographic). Mv°: 13.2. Size: 45"/110".

Riding along on the back of Hydra is the small constellation Corvus the Crow. The four brightest stars in Corvus form a neat trapezoidal pattern that stands out well against an otherwise barren portion of the southern springtime sky. Nearly centered within this distinctive pattern is the large, faint planetary nebula NGC 4361.

A 6-inch scope at 72x shows NGC 4361 as a misty patch of light surrounding a feeble central star. Increasing magnification enlarges and fades the nebula, as there is precious little detail visible in NGC 4361 and its surface brightness is low. This object lies some 800 parsecs from Earth.

A Ringtail for the 10-inch

Stats: Bright pair of interacting galaxies. Position (NGC 4038): 12h01.9m, -18°52'. Mv: 10.7 and 13 (photographic). Sizes: 2.6' by 1.8' and 3.2' by 2.2'.

While NGC 4361 may be the only planetary nebula in Corvus, the constellation is rich in galaxies. One of the best and most challenging such objects is the interacting pair composed of NGC 4038 and NGC 4039, the "Ringtail Galaxy."

A glance through my 8-inch reflector showed me that this object was a soft, 11th-magnitude glow that is evenly illuminated across its surface. While this description could fit a multitude of deep-sky objects, closer inspection revealed the galaxy's unique aspects. The amorphous glow slowly transformed into a hook-shaped image with a faint extension coming off toward the south. This elongation carries its own NGC number, 4039, and glows dimly at 13th magnitude.

Long-exposure photographs of the Ringtail Galaxy reveal two long, antennalike filaments extending from both NGC 4038 and NGC 4039. Extragalactic astronomers believe these "tails" have resulted from tidal forces caused by the passage of the two galaxies. Computer models developed over the last two decades dramatically show how a pair of interacting galaxies can leave these tails in their wake.

In 1943 the American astronomer Harlow Shapley showed that NGC 4027, a spiral galaxy lying less than 1° southwest of the Ringtail, has an almost identical redshift. Therefore, this galaxy may be weakly tied to the Ringtail system. Three other galaxies — NGC 3981, NGC 4024, and NGC 4033 — also lie relatively nearby and about the same distance away.

Aiming High for Copeland's Septet: A Challenge for 12-inch or 14-inch Telescopes

Stats: Galaxy group. NGC 3746: position: 11h37.73m, +22°00.6'. Mv: 15.3 (photographic). Size: 1.3' by 0.7'.

NGC 3745: position: 11h37.74m, +22°01.4'. Mv: >15. Size: 0.4' by 0.2'.

NGC 3748: position: 11h37.8m, +22°02'. Mv: >15. Size: 0.8' by 0.3'.

NGC 3751: position: 11h37.9m, +21°56'. Mv: 15.3 (photographic). Size: 0.4' by 0.3'.

NGC 3750: position: 11h37.9m, +21°58'. Mv: >15. Size: 0.9' by 0.7'.

NGC 3753: position: 11h37.90m, +21°59.0'. Mv: 14.6 (photographic). Size: 2.0' by 0.6'.

NGC 3754: position: 11h37.91m, +21°59.1'. Mv: >15. Size: 0.4' by 0.4'.

Readers with large telescopes face a difficult dilemma when planning a night's observing during this time of year: where to begin? No matter where your telescope is aimed, the chances are that at least one galaxy lies somewhere nearby. If you aim your scope 5.5° north of Denebola (Beta Leonis), for example, to a spot 1° northwest of 5th-magnitude 92 Leonis, you will be in the vicinity of a tightly packed galaxy group known as Copeland's Septet.

Brian Skiff of Lowell Observatory was the first to bring this group to the attention of *Deep Sky* readers, in the Spring 1983 issue. Observing from Flagstaff, Arizona, he wrote that four of the seven galaxies were visible in his 10-inch reflector. I tried duplicating his feat with an 8-inch reflector but to no avail. Last year after completing a 13.1-inch scope, I again looked toward Copeland's Septet. Straining to see through skies that didn't measure up to those of Flagstaff, I could just make out NGC 3750 and the close pair of galaxies NGC 3753 and NGC 3754. The former appeared like a tiny, round patch of light less than 1' in diameter, while the pair merged into a single blur. None appeared brighter than 14th magnitude. Although I failed to glimpse it, Skiff also noted NGC 3751. He called it a "marginal object" through his 10-inch scope.

The other three galaxies in the group are observable only with the largest amateur telescopes. NGC 3746 is a small barred spiral glowing dimly at photographic magnitude 15.3 and measuring 1.3' by 0.7'. This seems extremely faint, but it isn't when compared with the group's last two galaxies. Lying just 20' north of NGC 3746, NGC 3745 is a photographic magnitude 15.5 galaxy spanning only 0.4' by 0.2'. NGC 3748 appears slightly larger, some 0.8' by 0.3', but glows dimly at photographic magnitude 15.5.

Observers who successfully net all of these galaxies might want to experiment with stopping down their telescopes to determine the smallest aperture that shows the entire group.

Going for Local Group Dwarfs Leo I and II: A 16-inch to 20-inch Scope Challenge

Stats: Dwarf galaxies. Leo I. position: 10h08.4m, +12°18'. Mv: 9.8. Size: 10' by 8'.

Leo II: position: 11h13.5m, +22°10'. Mv: 11.5. Size: 14' by 13'.

Ironically two of the most challenging low surface brightness galaxies in the sky are two of the closest to home. Leo I and Leo II are dwarf elliptical galaxies a mere 230 kiloparsecs distant — only a third of the way to the Andromeda Galaxy.

After looking at their statistics, you might think these galaxies are visible in a 4-inch telescope. However, they're not. Leo I and II have extremely low surface brightnesses that make them difficult targets for the largest backyard telescopes.

In addition, Leo I is placed horribly for observation — in fact it is nearly drowned by glare from Regulus, the brightest star in Leo. Regulus lies only 20' south of Leo I. The best technique for finding Leo I is to use an eyepiece that yields enough power so Regulus lies outside of the field. Of course clean, well-collimated optics are a must, because the slightest dust or misalignment render Leo I invisible.

Leo II is located between two 9th-magnitude stars about 1.5° north of Delta Leonis. Shining with the light of a magnitude 11.5 star, Leo II is surprisingly difficult to find. If you can see this object at all, it will appear as an ill-defined glow.

As you take the cosmic challenge, make notes or sketches about what you see in various size telescopes. We'll look forward to hearing about your observations for future issues of *Deep Sky*.

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Deep Sky Reports
Reader's Page
by Steve Coe

If you have ever wanted to send an observation, photo, or eyepiece drawing to *Deep Sky*, now is the time. Reader's Page gives you the opportunity to contribute observations of a select group of objects previewed below. Each column will contain a selection of reader observations for each of the objects, so send your observations to Dave early to ensure that they are included.

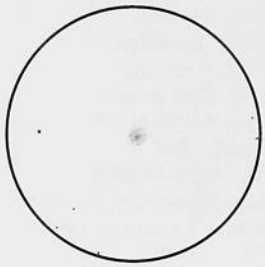
In the summer issue I'll discuss Scorpius objects NGC 6302, NGC 6334, NGC 6337, NGC 6380, and NGC 6451. The autumn article will focus on NGC 7448, NGC 7454, NGC 7469, NGC 7479, and NGC 7619-26 in Pegasus. Next winter we'll look at Gemini's NGC 2392, NGC 2371-2, NGC 2266, NGC 2420, IC 443, and J900. Next spring's column will include NGC 2903, NGC 3098, NGC 3162, NGC 3185-93, and NGC 3226-7 in Leo.

Because it's the first, this column features a few of my observations of Hydra objects. Hydra is a big constellation that holds a wealth of galaxies.

NGC 3109 is an 11th-magnitude edge-on galaxy. In my 17.5-inch scope at 100x it appears very elongated. At 165x I was able to see a distinctly stellar nucleus. This and other observations of mine were made from a dark-sky site in western Arizona that I rated as 7/10 for seeing and 6/10 for transparency.

Be careful when you observe **NGC 3203**: it is mislabeled as NGC 2303 on early printings of the "field edition" of Tirion's *Sky Atlas 2000.0*. NGC 3203 is faint, small, elongated, and has a reasonably bright middle at 100x.

NGC 3242 is one of the sky's best showpiece planetaries. Discovered by William Herschel in 1785, NGC 3242 acquired the nickname "Ghost of Jupiter" because William Henry Smyth thought it resembled the giant planet. Much later, in 1917, William H. Pickering proclaimed the central star disappeared in his 11-inch refractor. I have found no comment about when it reappeared. In my 17.5-inch scope at 320x, NGC 3242 appears strongly green and the central star is easily visible. On a good evening the central star and bright oval section remind me of the logo of the CBS Broadcasting Network. It gives me an eerie feeling to peer into the telescope and see something that appears to be looking back!



NGC 3242 sketched by A.J. Crayon using an 8-inch f/6 reflector at 200x.

The **Hydra I galaxy cluster** is a pretty rich group of faint galaxies. **NGC 3309, NGC 3311, and NGC 3312** form the central section of this cluster. NGC 3309 is pretty bright, small, round, and has an obvious star in the following arm. NGC 3311 is larger than NGC 3309 but also somewhat fainter. It is amorphous and gradually brighter in the middle. NGC 3312 is pretty bright, pretty large, and elongated by a ratio of three-to-one. It is the most readily noticed of the galaxies in the cluster, mostly because it has a bright core.

Observe these pretty objects in Hydra on some clear night this spring. And get out there and record your observations of Scorpius now — send them quickly for inclusion in the next issue. Make sure you send them to Dave, however, and not to me — I'll be busy writing the next column.

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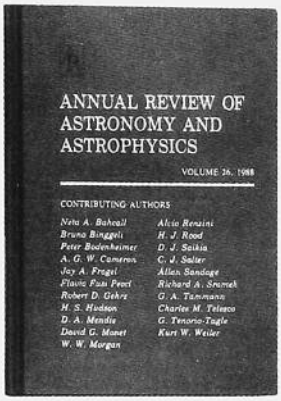
Deep Sky Reviews

The Best Deep-Sky Books of 1988

by David J. Eicher



Annual Review of Astronomy and Astrophysics, Volume 26, 1988
Geoffrey Burbidge, David Layzer, and John G. Phillips, eds.
703 pp., 6-1/4" by 9", hardcover, $47
ISBN 0-8243-0926-X
Annual Reviews, Inc., Palo Alto, California, 1988

Each year the new *Annual Review of Astronomy and Astrophysics* makes an important contribution to the astronomical literature. Capsulized between its covers are research summaries on the most active, hottest topics in astronomy over the past year. Thus, the book forms a kind of overview of what's currently happening in astronomy and who's doing it.

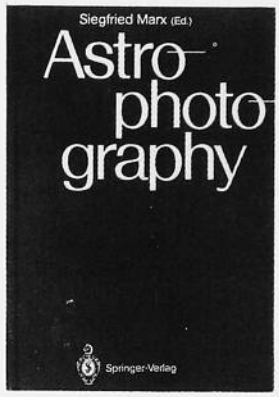
"My first encounter with the astronomical world was in 1920 or 1921," begins William W. Morgan, whose paper "A Morphological Life," opens the volume. The great stellar spectroscopist then describes his life and adventures in astronomy in a delightful nine-page narrative. Every year another accomplished astronomer holds the same honor of taking a philosophical look back at astronomy for the *Annual Review*. Other recent contributors have been William H. McCrea, A. E. Whitford, T. G. Cowling, and Jesse L. Greenstein.

Paging through what follows will in a few minutes give you a sense of what's currently going on in professional circles. Kitt Peak's Jay Frogel, for instance, describes the current state of knowledge on the galactic center and specifically the galactic nuclear bulge. In summary, Frogel informs us that "the part of the Galaxy we call the bulge, with a radius of about a kiloparsec, is a transition region between the young, active nucleus and the old metal-poor spheroid." After filling in the details, Frogel makes it clear that there is much yet to learn about the physical conditions of stars and gas in this region.

Herbert J. Rood, an expert on galaxy clustering, provides an excellent summary paper on extragalactic voids. Recounting the current state of void research, Rood describes how, after galaxy redshift surveys are analyzed by computers, we can get a pretty fair picture of where large voids exist. He then gives us examples of reduced data showing voids at several "layers" of distance. The final third of the paper reviews fine points of void research. Without having to become an expert on extragalactic voids, you can get a pretty fair summary of what's going on in that specialized area.

Thirteen other papers grace this volume, including Dave Monet's "Recent Advances in Optical Astrometry;" a detailed discussion of the luminosity function of galaxies by Bruno Binggeli, Allen Sandage, and Gustav Tammann; and a paper on large-scale structure by Neta Bahcall. Solar system research is represented by a review paper on comets by D. A. Mendis — "A Postencounter View" — A. G. W. Cameron's discussion of the origin of the solar system, and "Observed Variability of the Solar Luminosity" by H. S. Hudson.

Unless there is something here that you've craving, you may not want to drop $50 to purchase this volume. However, a trip to the library to read through papers that interest you, perhaps over a few sessions, is a good investment. In a few hours' reading you'll be up to date on what's hot in astronomical research.



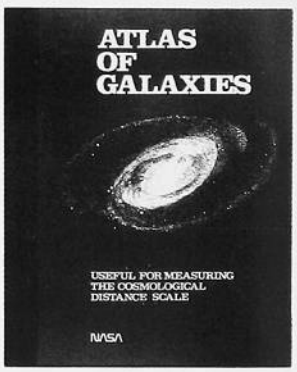
Astrophotography
Siegfried Marx, ed.
241 pp., 6-3/4" by 9-3/4", hardcover, $45
ISBN 3-540-18498-8
Springer-Verlag, New York, 1987

This book is a compilation of many fine papers presented at the International Astronomical Union's workshop on astrophotography held in Jena, German Democratic Republic, in April 1987. The technical papers in this book provide an interesting insight into astrophotographic techniques used by professionals at observatories around the world.

The book's introduction by David Malin of the Anglo-Australian Telescope, titled "The Age of the Specialist in Astronomical Photography," describes how major observatories now have in-house photographic departments. Malin emphasizes that "while at first glance the photographic plate fares badly when compared with other two-dimensional imaging devices such as the CCD, in fact these detectors are complimentary rather than mutually exclusive." After briefly describing the advent of advanced emulsions, hypersensitizing, and multicolor photography, Malin concludes by saying "techniques [like these] have led to the discovery of some of the most energetic and distant objects known."

The papers that follow range widely in scope. The papers "Atlas Copying on Film," "On the Employment of Copies in Astrophotography," "TheSuperimposition of Many Plates," and "Spectral Sensitivities of Hypersensitized Emulsions" contain information directly useful to backyard sky photographers. Others, such as "A Deep High-Resolution Survey of the Milky Way," "The Discovery of a Proto-Spiral Galaxy," and "Second Palomar Sky Survey — Photographic Procedures," simply make fascinating reading.

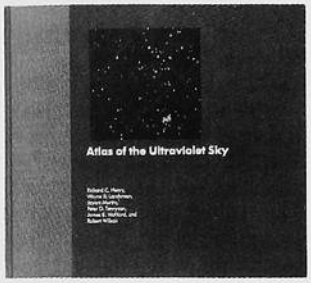
Astrophotography is a technical book that contains a wealth of information for those who are seriously interested in recording the sky on film.



Atlas of Galaxies Useful for Measuring the Cosmological Distance Scale
Allen Sandage and John Bedke
13 pp. + 95 plates, 16-1/4" by 20-1/4", hardcover, $80
National Aeronautics and Space Administration, Washington, 1988

Have you ever wanted a book containing poster-sized reproductions of many of the best galaxy photographs ever made? If so, this is your book. Sandage and Bedke's *Atlas of Galaxies*

contains 322 galaxy photos at large scale, compiled by astronomers to help determine distances by analyzing data such as sizes of H II regions, supernova remnants, or specific types of stars. The image area of the negative photos (black stars on white) is enormous — 14-3/4" by 18-3/8". Thus, the scale of the galaxies is correspondingly huge, which gives readers the ability to see many bright galaxies up close. If you're into galaxies, this book's for you.



Atlas of the Ultraviolet Sky
Richard C. Henry, Wayne B. Landsman, Jayant Murthy, Peter D. Tennyson, James B. Wofford, and Robert Wilson
457 pp., 10 3/8" by 9 1/2", hardcover, $65
ISBN 0-8018-3738-3
Johns Hopkins University Press, Baltimore, 1988

Paging through this atlas gives you a new view of the night sky. Each right-hand page of this book contains a map showing an 18° by 18° section of sky and the ultraviolet-emitting objects that lie within it. The corresponding left-hand pages show the same piece of sky in visible light.

Because it includes only hot stars, those emitting large amounts of ultraviolet radiation, the *Atlas of the Ultraviolet Sky* lets us look into a familiar sky and, at a glance, study the distribution of hot stars. For example, plate 101 shows the eastern half of Orion. All of the bright stars in Orion are visible in the ultraviolet map except for Betelgeuse, a cool red star.

Comparing the ultraviolet maps and their visible light companions in the *Ultraviolet Sky* gives the reader a powerful new appreciation of the types of stars that make up the night sky.

The Cambridge Atlas of Astronomy, Second edition
Jean Audouze and Guy Israel, eds.
431 pp., 10 1/2" by 14 1/2", hardcover, $90
ISBN 0-521-36360-8
Cambridge University Press, New York, 1988

In the world of astronomical reference books *The Cambridge Atlas of Astronomy* is hard to beat. Included in its large-format, colorful pages is reference material on virtually all aspects of astronomy and objects in the universe, and the presentation and explanations are superb. Five major sections highlight areas of astronomical research — the Sun, the solar system, stars and the Galaxy, the extragalactic domain, and astronomy as a science. Within a section we usually gets doses of explanation in groups of two-page spreads; for example, the Moon's chemistry, origin, and history receive a two-page spread, while the Moon's surface gets four pages. This compartmentalization continues throughout the book, which is richly illustrated with high-quality photos and diagrams.

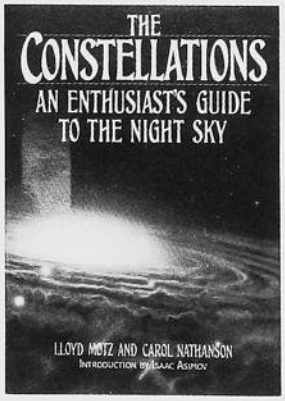
If you want an authoritative, lavish reference book, consider *The Cambridge Atlas of Astronomy*.

The Color Atlas of Galaxies
James D. Wray
189 pp., 9 1/4" by 12 1/2", hardcover, $79.50
ISBN 0-521-32236-7
Cambridge University Press, New York, 1988

Jim Wray's long-awaited *Color Atlas of Galaxies* is a landmark contribution to astronomical literature. It is the first published sourcebook of color galaxy images and as such is a valuable reference work for anyone who observes galaxies. (It is also lots of fun to simply page through when you're sitting around on a rainy evening.) Included are more than six hundred galaxies of all morphological types and luminosity classes.

After a brief introduction that outlines the selection criteria, photographic methods, and background on the project, the book consists of right-hand pages filled with photographs and left-hand pages filled with the explanatory captions. Sizes of the photos vary, and typically there are six or eight images per page. The reproduction is adequate, although the photos systematically appear somewhat yellow-green. This does not hinder seeing detail in the galaxies, however, so it is more of an aesthetic nuisance than a problem.

The quality of Wray's exposures is outstanding. Most of them were made with the McDonald 82-inch and 107-inch telescopes. (To shoot far-southern objects, Wray used the 40-inch telescope at Las Campanas in Chile.) The captions are most useful and include raw data and a brief, helpful discussion of the observed properties of each galaxy.



The Constellations: An Enthusiast's Guide to the Night Sky
Lloyd Motz and Carol Nathanson
411 pp., 7-3/8" by 10-5/8", hardcover, $24.95
ISBN 0-385-17600-7
Doubleday, New York, 1988

"With terrifying screams, the wind lashes angry water into great explosions of froth. Giant waves threaten to crush the fragile wooden hull of the sailship as it pitches to and fro. Huddled below, in the forecastle, the frightened sailors have already hauled in the sails, but this storm's appearance was so sudden that it has washed away most of their provisions and personal possessions." So begins *The Constellations*, which continues on to demonstrate how the sailors used a star to navigate the ship to safety. It is a gripping and powerful introduction to man's concept of the sky and the patterns of stars that compose it.

After starting to read the book, however, I discovered that this book really isn't about the constellations but a general guide to observing objects contained within them — a one-volume *Burnham's Celestial Handbook* without the data tables. Using constellations as chief subject matter quickly fades into a brief general discussion of celestial coordinates, stellar parallax, magnitudes, and spectra.

The utter beginner, introduced to astronomy by the sea story, finds himself sixteen pages later reading passages like "the bolometric magnitude of the Sun is arbitrarily placed equal to its absolute magnitude (+4.8). The bolometric magnitudes of stars in general are then obtained by a mathematical correction based on the differences between their surface temperatures and that of the Sun." Ouch! Toning down the technolesson might have helped make the book more friendly to beginners, who really don't need to know about bolometric magnitudes before they find Polaris.

Motz and Nathanson present descriptions of stars and deep-sky objects in constellations grouped by season. The authors further grouped constellations within seasons somewhat arbitrarily, leading to sections titled "Completing the Orion Scene," "Two Damsels and a Herdsman," and "More Animals." Within the constellations, we read a nicely woven text describing what is there. However, the authors stop short of relating what is visible to the

naked eye or in various size telescopes. They simply report, as if someone read and interpreted a detailed map and a catalogue of information for you. At certain points the authors break into this discussion with related facts about the universe or about how astronomers gather information about it. These sections show the greatest success rate. The text is illustrated with 156 photographs and line drawings.

Unfortunately the book presents a mixed array of information. The coordinates used for discussing objects are in equinox 1950. The figures given for magnitudes, sizes, and distances of objects frequently represent old data, which means they are often wrong. This happened despite the fact that *Sky Catalogue 2000.0*, filled with more modern information, appears in the book's bibliography.

The authors provide their own system of star nomenclature, which leads to some ambiguities. Delta Canis Majoris is presented as "WEZEN (delta) DELTA" under the heading "Greater Dog." And 20 Tauri is given as "Fl. #20" under the discussion of stars in Taurus. Positions are given in the format R.A. HHh Mmm, (delta) DD° MM'. One wishes the authors would have conformed to more familiar usage. The absence of observational information further hurts the readability of a text bulging with numbers, statistics, and names unfamiliar to nonastronomers.

The lack of observational know-how hits hardest in places like the introduction, where the authors fail to mention Tirion's star atlases but recommend *Edmund's Mag. 5 Star Atlas*, *Norton's Star Atlas*, and *Putnam's Field Book of the Skies*. This is also a glaring tip-off that some of the book's advice is outdated.

I wish that *The Constellations* was a better book. It could be. However, to make it more useful, the authors should update the data used to support what they say, inject the book with a healthy amount of observational information, and emphasize the focus on the constellations. Until that time the book offers little that is new.

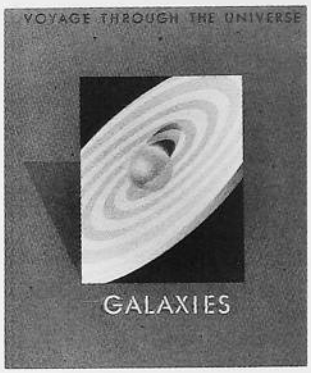
Cycles of Fire: Stars, Galaxies, and the Wonders of Deep Space
William K. Hartmann
and Ron Miller
189 pp., 10" by 10", paper, $14.95
Workman Publishing, New York, 1987

Cycles of Fire is a popular book describing the components and inner workings of stars and galaxies. It is lavishly illustrated with airbrush paintings by Hartmann and Miller and is a joy to page through. The text is written so that anyone can understand the concepts involved, and a few photographs and diagrams scattered throughout the book supplement the artwork.

The art, the book's primary reason for being, is generally very good. Good art ought to show us things we can't see by other means, and the authors succeed in doing this. There are a few pieces that appear too "brushy" to be realistic, which destroys the effect of portraying a hypothetical scene. I don't think the authors gained anything by painting morphological types of galaxies when multicolor CCD images made with big telescopes show the real thing better. But the artwork is excellent and gives readers a new perspective on stars and galaxies in the universe.

Exploring with a Telescope
Glenn F. Chaple, Jr.
142 pp., 6 1/4" by 9 1/2", hardcover, no price given
ISBN 0-531-10581-4
Franklin Watts, New York, 1988

Looking forward to having your kids follow in your footsteps as talented deep-sky observers? Then I recommend getting a copy of Glenn Chaple's *Exploring with a Telescope*. Chaple, a long-time contributor to *Deep Sky*, has over the past few years developed a very successful column in the children's magazine *Odyssey*. His book captures the enjoyable, noncondescending approach of his *Odyssey* columns, which gives kids an overall guide for observing the sky.

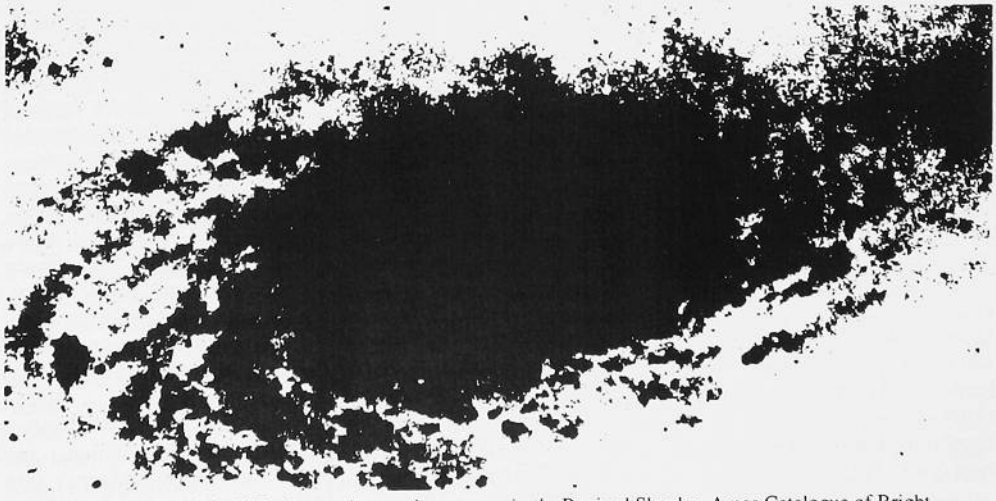


Galaxies
The Editors of Time-Life Books
144 pp., 9-1/4" by 11", hardcover, $14.95
ISBN 0-8094-6850-6
Time-Life Books, Alexandria, Virginia, 1988

Galaxies is the first book in a projected twenty-book series called *Voyage through the Universe*, produced by Time-Life Books. The basic plan here is to take the successful Time-Life formula — provide a basic introduction to a subject and supplant it with lots of colorful illustrations — and apply it to astronomy. After all, it has worked with everything from home repair to the old west to "mysteries of the unknown."

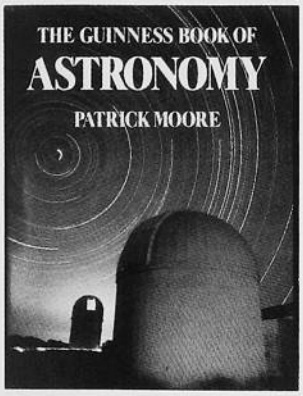
The book is divided into four sections that cover galaxies in general, the Milky Way, unusual types of galaxies, and mysteries that plague research.

The text in *Galaxies* is sound and well written, and the use of photographs and color, air-



This image of M63 (NGC 5055) is one of many that appear in the Revised Shapley-Ames Catalogue of Bright Galaxies, *an invaluable reference tool for galaxy observers. The book holds fundamental data for 1,246 galaxies and many exquisite photographs.*

brushed diagrams is outstanding. Through a colorful, well-illustrated journey, novice readers come away with a good basic understanding of what galaxies are and how they work. *Galaxies* can be recommended for those who want a simple introduction to the subject.



The Guinness Book of Astronomy
Patrick Moore
288 pp., 7-3/4" by 10-1/2", hardcover, $19.95
ISBN 0-85112-375-9
Guinness Books, Middlesex, England, 1988

Patrick Moore's *Guinness Book of Astronomy* gives astronomy the trademark Guinness treatment: listing the biggest, first, longest, highest, and deepest. A textbook of facts fits neatly into a manual that summarizes in Guinness style objects of interest in the universe.

The book is structured well, beginning with a discussion of the solar system and its inhabitants. Included are such useful reference lists as lunar craters on the Moon's far side, lunar probes, features on Mars, minor planets, satellites of all planets, planetary opposition dates, and many other useful bits of information. Next comes a brief section on the stars, followed by an extensive star catalogue with maps showing stars down to magnitude 5. Follow-ing this, there appears an interesting section on telescopes and observatories and then an astronomical chronology and a short section of astronomical bio-graphies.

Overall this book is a surprisingly useful one to keep on your reference shelf. Only one danger exists for a book so loaded with "firsts" and "mosts" — in a few areas it will quickly become outdated. Nevertheless, this book contains a great deal of valuable information and is captivating to browse through.

Handbook of the Constellations, Fifth edition.
Hans Vehrenberg
and Dieter Blank
197 pp., 11" by 8", bound in vinyl notebook, $39.95
Treugesell-Verlag, Dusseldorf, West Germany, 1987

The fifth edition of this venerable classic presents fifty-five white-on-gray star charts showing bright stars and deep-sky objects in all of the major constellations. The star charts appear on each right-hand page; the facing page contains a catalogue of data for the major objects shown on the corresponding map. The scale of 1°/4mm per degree is consistent throughout, which is a benefit to the large constellations but crowds the small ones — and "busy" areas like Sagittarius — with type and symbols.

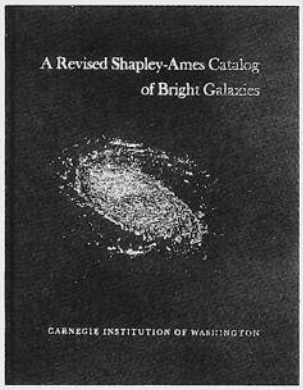
Nevertheless, Vehrenberg and Blank's book makes a handy reference to keep beside the telescope. The catalogue provides an excellent list of bright targets for nights under a dark sky, and the maps give enough detail to find the objects with ease. Unfortunately the authors resisted using equinox 2000 coordinates, but this is a minor point. The availability of a new edition of Vehrenberg and Blank's book is a welcome start for the new year.

Norton's Star Atlas and Reference Handbook,
Seventeenth edition
Arthur P. Norton
116 pp. + 18 maps, 8-3/4" by 11-1/4", hardcover, $XX
ISBN 0-582-98898-5
Longman Scientific & Technical and John Wiley and Sons, New York, 1986

The time has come for a major updating of good ol' *Norton's Star Atlas*. For many years the amateur astronomer's standard set of star charts and still a favorite of some observers, *Norton's* is in for hard times ahead. Originally published in 1910, this manual now faces an era when being a classic loses its meaning and competing with *Sky Atlas 2000.0* and *Uranometria 2000.0* becomes the number one task.

The inescapable fact is that times have changed. Telescopes are different than they were long ago, the objects backyard observers can see are much fainter than they used to be, and the sophistication of modern observers is far greater than it once was. The result is that even with the updating it has received, much of the text in *Norton's* reads like it belongs in a museum case. Even worse, its star maps have a relatively small scale (about 1°/3mm) and are cluttered with old-fashioned, unfriendly, nonstandard symbols. And besides, everybody knows the Milky Way isn't bright green!

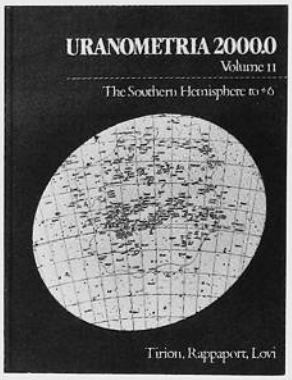
In an age when observers use large telescopes to look at faint objects, *Norton's* must consider going back to the drawing board. Else the tremendous success of *Sky Atlas 2000.0* and *Uranometria 2000.0* will indeed make a museum piece out of dear ol' *Norton's*.



A Revised Shapley-Ames Catalog of Bright Galaxies, Second edition
Allen Sandage and G. A. Tammann
157 pp., 9 1/2" by 12 1/2", hardcover, $29
ISBN 0-87279-652-3
Carnegie Institution of Washington, Washington, 1987

Originally published in 1981, the *Revised Shapley-Ames Catalog* is a landmark work of galaxy cataloguing that includes beautiful negative plates made with large observatory instruments. This second edition contains revisions in the form of data taken from additional plates, updated information in several of the tables, and reformatting. The result is an improved version of an already top-notch work.

If you like to observe galaxies, the *Revised Shapley-Ames Catalog* (*RSA* for short) should be on your library shelf. Even if you're not interested in the data (which is fascinating to mull over), you should have this book for the exquisite photography. Included are eighty-four plates that comprise a study of all morphological types. As such, it is a terrific companion for cloudy nights.



Uranometria 2000.0, Volume II: The Southern Hemisphere to -6°
Wil Tirion, Barry Rappaport, and George Lovi
258 charts, 9" by 12-1/4", hardcover, $39.95
ISBN 0-943396-15-8
Willmann-Bell, Inc., Richmond, Virginia, 1988

This second volume of *Uranometria 2000.0* completes what is currently the most sophisticated and useful star atlas for backyard astronomers. The format follows that of the first volume: each page depicts an approximately 13°-by-9° chunk of sky. Stars down to 9th magnitude are plotted, as well as numerous deep-sky objects that were not plotted on the previous top-of-the-line atlas, Tirion's *Sky Atlas 2000.0*.

Together the two volumes of *Uranometria 2000.0* form a set that is invaluable to all deep-sky observers, regardless of their experience or the sizes of their telescopes. This atlas sets a high standard that places it among the select few books that *must* be present on the shelf of every amateur astronomer.

Small Scope Showcase

Springtime Discovery

by Alister Ling

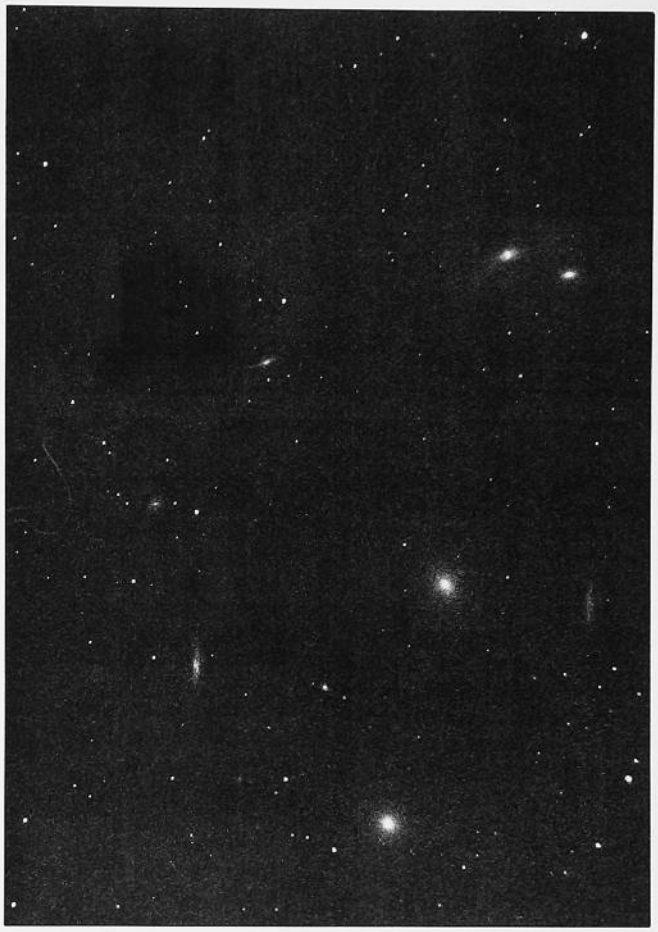
My most memorable trek through the Coma-Virgo cluster remains my first, just over eight years ago. I can recall quite distinctly that wonderful night: the black Adirondack sky was filled with more stars than my novice eyes could believe, while the −20° F air was scented with scotch pine needles burning in nearby houses.

It was January, one of my favorite observing months. Spring has always been a poor time for me. We in the mid-latitudes are frequently hit by mighty storms, and the students among us are beset with final exams during the two weeks of New Moon. On the other hand, January nights are exquisitely long and clear. That particular night was one of discovery for me. The next clear night can be one for you as well, no matter what your level of experience or the size of your scope.

Another problem faced by those of us on the northern edge of things is the Sun speeding toward summer solstice. As Virgo slides westward, the Sun sets ever later, robbing us of one of the universe's treasures. We should be thankful: the nights of spring aren't as cold, and the air is swept clean of dust by the storms. The cooler air behind a cold front matches the cold ground to reduce local seeing problems that abound on fall nights. Yes, this is the time of year you can push your eyes and your scope to their limits.

In those days I rarely planned an observing session — I was going to tour the heavens! Even then I knew I needed help with the Coma-Virgo cluster. *Norton's Star Atlas* simply couldn't cope with the density of galaxies. Vehrenberg's *Atlas of Deep Sky Splendors* came to the rescue. Not only did the large scale help me find my way in each field of my 4.5-inch reflector, but the diagram of the entire cluster served as my road map.

My route started at 6 Comae, an easy naked-eye hop from Leo's hindquarters. I quickly spotted **M98**, **M99**, and **M100** in the adjacent fields. Next I hopped up to **M85** and then moved back southward to **M88**. But wait! Here was a fuzzy blob in the field at 30x, **NGC 4450**. I had received the impression from the observing books that I would only be able to see Messier galaxies with my small telescope. What a thrill it was to do the "impossible." The die was cast — from that time hence I would attempt the so-called impossible at every opportunity. And you know what? It rarely ends in failure!



The Virgo Cluster presents an area splattered with galaxies visible in small telescopes. Near the center of this photo lie M84, M86, and a host of NGC galaxies. Photo by Tom Dessert (10-inch f/6 reflector, 103a-O film, 20-minute exposure).

If you're just starting out, you may simply want to discover each galaxy one by one. Observers with trained eyes can look at the different galaxy structures: ellipticals here, spirals there (any dust lanes?). Take your time, there's no hurry. After all, the galaxies will still be there next year!

The problem of identification of galaxy fields is one every observer must face. Of course, even if you are an expert at navigating the Coma-Virgo cluster, you will have difficulties elsewhere. My first run in with an identification difficulty occurred as I was star hopping to **M49**, toward the southern parts of the galaxy swarm. With my trusty 4.5-inch scope, I ran headlong into **NGC 4526** and quickly jotted down M49 in my notebook. As soon as I looked at the Vehrenberg photograph, I noticed my error: the stars through the eyepiece did not match those in the picture. The real M49 lay another field away. To this date I've kept my suspicions nicely honed. Never assume you are looking at the right object if you are observing it for the first time.

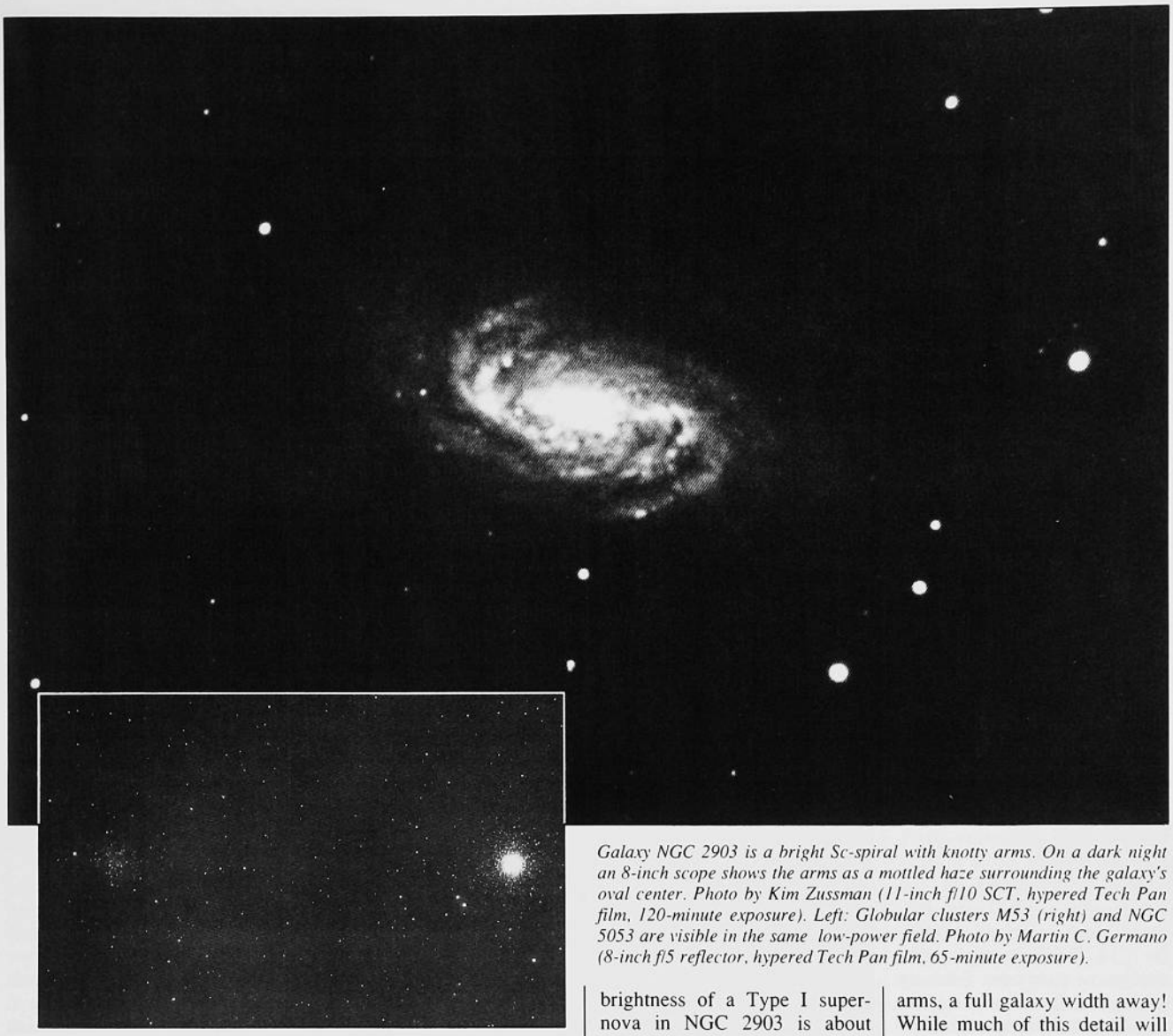
I wish I could tell you how these objects looked to me. Unfortunately in the old days all I placed in my observing log were numbers, and I have not had the opportunity recently to spend enough time in this region of sky to tell you more. Yet every one of these objects deserves a closer look.

I would like to demonstrate how a small scope can do more than a large scope, given a trained eye. This case involves the seldom observed **NGC 5053**, a globular cluster next to the bright and easy globular **M53** in Coma Berenices. The following observation was made by Tom Matty from Edmonton, Alberta, using only an 8-inch f/6 scope:

"An unresolved elongated oval about 3:2 in an east-west direction. It appears to have very rough edges hinting at some arms of stars coming off. It is hard to tell as it is so diffuse. I can manage to pull out three or four stars with difficulty at 80x and 140x. After some time, I could discern two slightly brighter arms of nebulosity as part of the main object, one stretching north following (NE) and one south following (SE)."

Now that's an observation! Descriptions from the Webb Handbook range from a 10-inch "Best at LP; a few stars seen at centre x296" through a 12-inch "x250 very difficult" to a 16.5-incher "x70 diffuse spot with few stars resolved; still sparse but completely resolved x222, x333."

Naturally Tom did not simply glance at NGC 5053. With his 8-inch reflector it took him



Galaxy NGC 2903 is a bright Sc-spiral with knotty arms. On a dark night an 8-inch scope shows the arms as a mottled haze surrounding the galaxy's oval center. Photo by Kim Zussman (11-inch f/10 SCT, hypered Tech Pan film, 120-minute exposure). Left: Globular clusters M53 (right) and NGC 5053 are visible in the same low-power field. Photo by Martin C. Germano (8-inch f/5 reflector, hypered Tech Pan film, 65-minute exposure).

about thirty minutes, but I think you will agree with me that it is by far the most detailed description.

I do not wish to dismiss the casual observer here — observing is such a deeply soothing and peaceful activity that only you can decide what you want. However, try not to think of "hard-core" observing as a chore. All it requires is patience. Experience the thrill of stretching your visual system to the edge and subsequently confirming your discoveries on a photograph!

Remember that pictures aren't everything: many objects are overexposed to catch outlying fainter areas, which result in a burnt-out central region. Often the scale is too small, and that means you can't resolve clusters and small planetary nebulae better than photographs. It is here you can see the who as it "really" is.

One of my favorite galaxies is **NGC 2903** in Leo. It's so easy to find, I can hop to it in a 50mm finder through city lights. But it was only last year that I enjoyed a fantastic view through David Levy's 16-inch reflector. The mottled disk and bright central area were pleasing sights as I started in on some supernova hunting with the aid of Gregg Thompson's chart.

These soon-to-be-published charts make it possible for small scope users to participate in supernova hunting. One "advantage" is that a smaller aperture will not show you dozens of field stars, so you'll be able to remember the charts more easily. The expected maximum brightness of a Type I supernova in NGC 2903 is about 10.8, so that's well within reach from country skies.

Before jumping in, take a few minutes to appreciate the grandeur of the sight before your eye. NGC 2903 is the only single galaxy in Sir William Herschel's catalogues with two numbers. See for yourself whether you can pick out a double central region. After all, your 8-inch scope should collect as much light as his 12-inch speculum did years ago.

After several sessions of pushing yourself, you will recognize that you can now see more detail than ever before! One of the biggest advantages of Gregg's supernova charts is that he has reproduced them so you can see inner and outer detail at the same time. With the chart as a guide, I was able to detect some incredibly faint H II knots embedded in the spiral arms, a full galaxy width away! While much of this detail will be lost in the smaller apertures, it can give you something to strive for. Make the effort to note down as much as you think you can see or perhaps only a certain portion and then check it against a picture. You'll surprise yourself. Keeping a book of your own observing notes not only shows you your increasing skill over the years, but reading it a decade later will bring back some very fond memories.

This spring why not pause during your Messier Marathon and take a walk on the wild side? Better still, relax and spend time digging for subtle detail. You won't be disappointed.

1017 Seneca Avenue #310
Mississauga, Ontario
Canada, L5G 3X5

Double Stars
Full Moon, Canes Venatici
by Brian Skiff

It was less than two days before Full Moon but close enough to make the deep-sky observer in me feel awkward about using a telescope. I had a feeling the seeing would be good: the following day a late-winter storm was due, and the night prior to such an event often proves steady. At sunset prefontal cirrus appeared on the western horizon — not a good night to do photometry, my main astronomy-for-pay work.

Armed with my observing list, I arrived in early twilight at Lowell Observatory's Anderson Mesa site, where my 6-inch refractor stands in the dome housing the venerable 13-inch "Pluto camera" telescope. Inside the fenced compound, sitting with a C14 and an array of electronics, is Wean Tsay, a Taiwanese student studying at Georgia State University. As a graduate project, he is making nightly measurements of the seeing with a CCD and PC-based "frame-grabber" through the C14. While there is light enough, he puts some finishing touches on the software he has written to analyze the data. We agree to compare later what the seeing is visually and with the CCD setup.

For starters, I check **ADS 6263**, a fairly bright, equal pair that lies just east of Procyon, currently separated by only 0.92". Even though it is lowering in the west two-and-a-half hours past the meridian, the pair is cleanly resolved at 295x. When the Airy disks are obvious (about 0.85" across at 6-inches aperture), that's good seeing.

Practically the only place to start in Canes Venatici is the centrally located **Cor Caroli** (Alpha Canum Venaticorum). It was easy in the telescope's 30x "finder" eyepiece. Because the components are bright, it should be easy in even the smallest instruments and "giant" binoculars.

When Glenn Chaple wrote about this region in the May 1982 issue of the old *Deep Sky Monthly*, he recounted the wildly different colors attributed to this pair by observers in the last century. Much of the apparent difference, he correctly noted, arises from the fairly large brightness difference between the stars, which amounts to 2.7 magnitudes.

However, there is a significant real color difference. The primary is a hot, chemically peculiar star with a photometric B-V color of –0.12, which makes it somewhat bluer than Vega. The fainter star is a garden-variety F dwarf with a B-V of +0.34, about that of Procyon. These values would suggest the colors bluish white and a nearly pure white with a hint of blue.

But the magnitude difference played its physiological tricks on me: at 165x I saw them white (with a weak blue halo from the remnant chromatic aberration in the apochromat) and greenish.

About 1/2° east of Cor Caroli is a wider and much fainter pair, **Struve 1702**. Glenn also discussed this star at some length, noting magnitude differences published in various places, which range from 0.3 to 1.5. Under the Full Moon I estimated a delta-m of 0.6 or 0.75. More recently I measured the components using the photometer on the Lowell 21-inch scope and found a delta-V of 0.70 ±0.01; the magnitudes are roughly 8.7 and 9.4. This is a physical pair of stars that are similar to the Sun and share a common proper motion.

Double Stars in Canes Venatici

Name	Mags.	sep.	pa.	year	spectral type
ADS 8289	5.7, 8.8	11.5"	260°	1973	M1III = F7V
ADS 8495	7.2, 10.1	6.1"	150°	1916	A2.5V
ADS 8516	6.7, 10.3	10.1"	193°	1971	KOIIIb = F9V
ADS 8546	8.4, 9.2	2.5"	180°	1977	F5
ADS 8561	7.5, 8.1	9.9"	158°	1981	F9V =g4v
ADS 8651	7.2, 9.2	0.8"	112°	1979	Am
ADS 8706	2.9, 5.6	19.4"	228°	1974	ApSrEuHg + FOV
Struve 1702	8.7, 9.4	35.7"	83°	1950	G5V + G6V
ADS 8769	7.9, 10.5	2.6"	124°	1984	—
ADS 8795	7.3, 8.6	6.4"	8°	1977	G2IV-V
ADS 8814	7.2, 7.7	2.3"	240°	1983	F6V
ADS 8815	8.2, 9.9	2.0"	341°	1982	—
ADS 8852	8.2, 10.1	7.1"	268°	1936	—
ADS 8933	10.2, 10.6	6.7"	163°	1932	—
ADS 8934	7.3, 8.2	4.4"	131°	1984	G5III
ADS 8974	5.0, 6.9	1.8"	102°	1989	A7III + FOV
ADS 8981AB	7.9, 10.3	2.0"	39°	1980	AB: G5V
AC	7.9, 9.2	56.1"	259°	1964	C: k2v
AD	7.9, 11.8	167.6"	194°	1922	—
AE	7.9, --	151.5"	175°	1922	—
ADS 9020	7.7, 9.9	2.2"	49°	1962	KO

Notes:
ADS = 2 CVn - B-V = 1.55 and 0.57. ADS 8516 - B-V = 1.00 and 0.58. ADS 8561 - spec type of companion inferred from UBV colors ADS 8651 - B-V 0.30. ADS 8706 = CVn - Cor Caroli. B-V = - 0.12 and +0.34 primary is slightly variable. ADS 8974 = 25 CVn - sep and [a from orbit ephemerides, combined B-V = 0.23. ADS 8981 - spec type of component C inferred from UBV colors.

With that warm-up I began to go through my observing list systematically by first star hopping to the west side and then working eastward as the constellation rose higher.

ADS 8651 was not resolved even at 295x. The separation is only 0.8", close to the limit of the telescope. But the stars are magnitude 7.2 and 9.2, and I've found that if the secondary is below about 7.5 I can't reach the diffraction limit. The significant magnitude difference in this case is also a hindrance. Probably an 8-inch telescope is necessary to resolve this pair — or the 6-inch on a dark night!

ADS 8516 is another unequally bright pair, but this one was easy at 80x. Those with larger instruments may see a color difference in this pair. About 12' southeast is a very wide pair of magnitude-10 stars lying 1.3' apart.

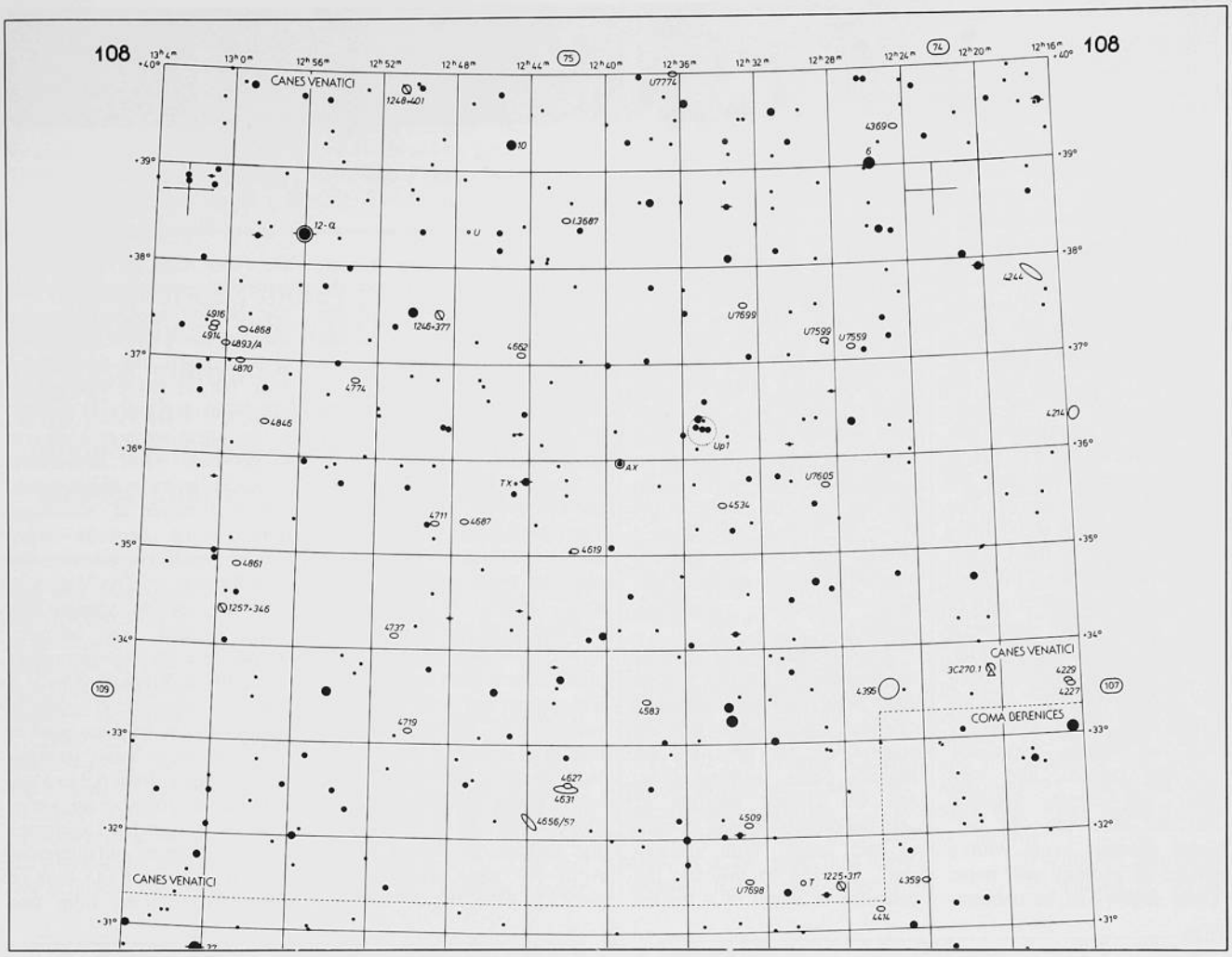
ADS 8495 has a similar appearance, but the two stars are closer and (to me at least) the magnitude difference is not so large as with ADS 8516. The pair and a third star about 2' southeast were well observed at 80x.

The star **2 Canum Venaticorum** (ADS 8489) is a bright, easy pair for small telescopes that shows a clear color contrast. I saw the stars as orangish yellow and powder blue. The spectral types and B-V colors indicate the blueness of the companion is exaggerated by the magnitude difference; the primary is indeed a cool M-giant star.

Slightly fainter but still easy is **ADS 8561**, which I could resolve at 30x. Not far to the west is **ADS 8546**, a nice pair for 80x.

ADS 8769 was "a pleasantly tough unequal pair," according to my notes, and was resolved at medium-high powers. I estimated a delta-m of 2.5 to 3, which agreed with the *WDS* value of 2.6.

The trio of **15, 16,** and **17**



This section of Uranometria 2000.0 depicts several of the double stars mentioned in this article. Copyright 1987 Willmann-Bell, Inc.

Canum Venaticorum make a nice grouping for finder scopes. On the northwest side of this asterism is **ADS 8795**, a moderately close pair for low and medium powers (I got them at 50x).

Among my favorite types of doubles are those of about magnitude 7 or 8, nearly equal, and 2" to 4" separation. These appear very close but resolved in the 80x eyepiece I use for short-distance star hopping. One such pair is **ADS 8814**. I estimated its delta-m at 0.2 or 0.3, while the *WDS* magnitudes imply 0.5. Another similar pair is **ADS 8934**, which lies farther northeast. There are some other pairs in this field: two very wide uncatalogued pairs lie 9' east-southeast (about magnitude 10, 35" separation) and farther south a little east (magnitude 11, 55"). Near an orangish, magnitude-8 star 25' southwest is **ADS 8933**, which I spotted at 80x.

ADS 8815 might have been easier without the bright moonlight: the 10th-magnitude companion was relatively difficult to see at 165x. Similarly **ADS 8852** was a problem, but here the companion seemed to me to be about magnitude 11, not magnitude 10 as the *WDS* states.

By the time I reached **25 Canum Venaticorum** (ADS 8974) in the southeastern quadrant of the constellation, the seeing had gone soft, and at high power the images were puffy. Thus, the view of this star was not as crisp as I had expected for such a bright pair.

I stopped viewing and trotted over to Wean working at the C14 about one hundred yards away. Yes, he too had noticed the worsening, and the latest reading showed the images to be 2.3" across "full-width half-maximum," the point where the image profiles fall to half their peak brightness — a criterion similar to what one sees visually in a moderate aperture.

I decided to press on to see how the seeing would affect viewing. **ADS 8981** was pretty tough: the close pair required 195x for a clear shot, though the more distant C and D components were a cinch. **ADS 9020** was a little easier because the components are brighter.

By now the stars were total mush, and the first wisps of cirrus were passing in front of the Moon. A final check with Wean: 4". Ugh!

The one advantage of restricting one's viewing to the brighter doubles (all these were selected from the *Sky Catalogue 2000.0,* volume 2) is that you needn't worry much about getting or staying dark-adapted. And, except when you're seeking out faint companions (as noted above), bright moonlight is okay.

However, there are some drawbacks. As you peruse an atlas for the pairs discussed here, you'll note that the big, bright galaxy **NGC 4244** lies just 32' west-southwest of ADS 8561; ADS 8561 is in the same field with **NGC 4460**, a moderately faint spindle-shaped galaxy easy to see on a dark night with a 6-inch. On another Full Moon night, I made the mistake of viewing pairs in Auriga — and totally missed out on seeing the fine starry fields along the way, thereby missing seeing the pairs in context with the Milky Way.

I rather like being distracted by galaxies and beautiful starfields: observing for me is a therapeutic exercise not to be diluted by a bright Moon. The lesson is clear to me, although not completely unambiguous: the sky offers a wide array of experience and you must use each circumstance to its best advantage.

1400 West Mars Hill Road
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It's funny that as the seasons change and new numbers of *Deep Sky* appear, the writers often begin their work with a comment about how a particular season is so important for observing. We see the same thing in other magazines too. Summer articles begin : "This is the best time of the year for observers and mosquitoes. The warm, comfortable nights offer gorgeous views of the Cygnus Milky Way." Articles intended for autumn open with a sigh of relief: "Now that summer's awful heat and storms are past, we can get to the serious business of observing" or "Autumn is the time when astronomy clubs are starting their new observing seasons, and with cooler and clearer weather, what fun observing can be!" Winter writings begin with a mixture of apology and hope: "These nights can be unbearably cold, but they certainly offer stunning views of Orion."

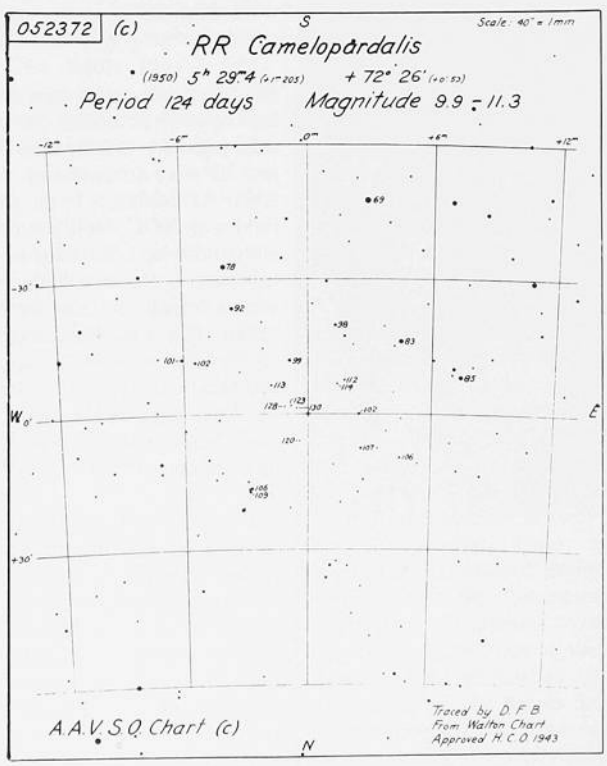
With this spring issue I would like to write something nice about spring. Sometimes it's hard to! I remember late April nights in Nova Scotia that were so cold it might as well have been winter. With warm clothes put away, we just froze. But we think of spring as the return of warmth and nature's rebirth, and it is true that the comfort of warm spring nights really makes observing pleasant.

Amateur astronomy reaches out desperately for that special clear night. We are confirmed calendar watchers who plot the courses of our lives by the Moon's phase, sidereal time, and the chance position of celestial objects passing in front of each other. With variable stars, we add to this list the behavior or whim of a distant star. All these events happen regardless of season, but the conditions and comfort of our observing do depend on the season. When we are outside and remove telescope covers for a night's work, we are very aware of the conditions dictated by Earth's orbit.

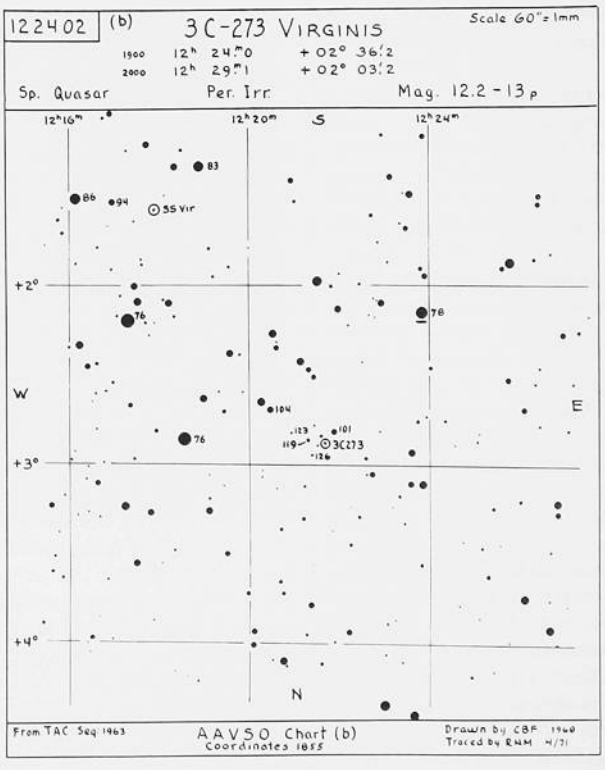
Seasons depend, of course, on where you happen to live. Terence Dickinson once told me that in Ontario where he observes a reasonable night is a long sought-after event. The summer nights are so mosquito-infested that one must dash for cover after a short spell outside late autumn and early spring are cloudy and winter's subzero cold is so wretched that observing becomes an ordeal. That leaves about three weeks beginning at the end of September and another two weeks in late April for about five possible weeks of observing a year. On the other hand, in Tucson we have only two seasons, dry and wet. No one observes during the summer rains, and it may cloud over and rain the rest of the year, but we enjoy nice conditions when it doesn't.

Our attention to seasons is a bit geo-chauvinistic, as we variable star observers like to think. Mira's summer at maximum light, which happens every eleven months, is an event we look forward to. The Mira-type stars are regular enough that their "seasons" can be predicted. Here are some examples.

123307 R Virginis. This is a Mira or long-period variable star, the first to be discovered in the constellation Virgo. Its magnitude range is from 6.9 to 11.4, but like all long-period variables, R Vir can have extremes of both maximum and minimum light. Its period of 145 days or about five months from one



The AAVSO "c" chart shows a telescopic view of the field surrounding RR Camelopardalis. South is at top and west at left. All charts used by special permission of Janet A. Mattei, director, AAVSO.



Although it isn't a variable star, quasar 3C 273 is a favorite object for variable star observers. The "b" chart shows a very low-power telescopic view of the 3C 273 field.

maximum to the next is unusually fast. Find this star about 8-1/2° north of the double star Gamma Virginis.

You can also use Gamma Virginis to find **122001 SS Virginis**. Move your telescope about 4° west and 2° north to find this long-period variable. SS Vir changes over a shallow range of two magnitudes, from 6.6 to 8.7, in a period of 358 days, almost exactly a year. Its "seasons" almost match ours!

122402 3C 273 Virginis. One-and-a-half degrees north and 1° east of SS Virginis lies and object that isn't a star at all, let alone a long-period variable, but a quasar. Its irregular variation brightens and fades by a magnitude; normally SC 273 glows at about 12th magnitude.

154639 V Coronae Borealis. Another Mira star with a period close to a calendar year, V Cor Bor varies over a period of 358 days with a range from magnitude 7.8 to magnitude 11.3. Although it does not lie near any named stars, V Cor Bor does mark the common border of Corona Borealis, Bootes, and Hercules.

1515-20 S Librae. A period of 192 days, about half a year, marks this long-period variable. The four-magnitude range, 8.5 to 12.3, is a bit shallow for long period variables. Find this star a little over 1° east and north of the globular cluster NGC 5897.

164025 AH Herculis may be easy to find, just 2° west and 1/2° north of 51 Herculis. It is a Z Cam-type star, its behavior predictable only with difficulty. Under normal conditions it will erupt every 19 days from a minimum of about 14th magnitude to a peak of about 9.5 magnitude. However, Z Cam stars tend to stall about halfway between maximum and minimum, and when you observe it, AH Her may well stabilize around 12th magnitude in a standstill that might last for months.

1247-28 EX Hydrae. This variable undergoes outbursts like SS Cygni, although the period between eruptions is much longer. Its minimum is around 13th magnitude, and during outburst it may reach 11th magnitude. In addition, the star is an eclipsing binary with a 0.6-magnitude variation that is detectable with difficulty when the star is not in outburst.

163137 W Herculis. A long-period variable with a large variation from magnitude 7.3 to 14.5, this star varies over 280 days, or a bit more than nine months. It lies just over 1° northwest of the globular cluster M13.

185243 R Lyrae. Becoming easily visible in late spring, this semiregular variable is famous for its red color. R Lyr varies over a magnitude from about 4.0 to 5.0.

052372 RR Camelopardalis is a circumpolar star for most Northern Hemisphere observers. It ranges from magnitude 9.9 to 11.3 over 124 days — just a bit over four months. You can watch this conveniently visible star through much of its entire cycle uninterrupted by risings and settings. This is a star for all seasons.

154428 R Coronae Borealis. We discussed the behavior of this unusual star last issue and wondered what its future course would be. As R Coronae Borealis began to climb past 10th magnitude last November, it also reached conjunction with the Sun and was difficult to observe. On the morning of January 1, 1989, Peter Collins and I observed R Cor Bor at magnitude 9.1, and in the week after that Peter noted further brightening.

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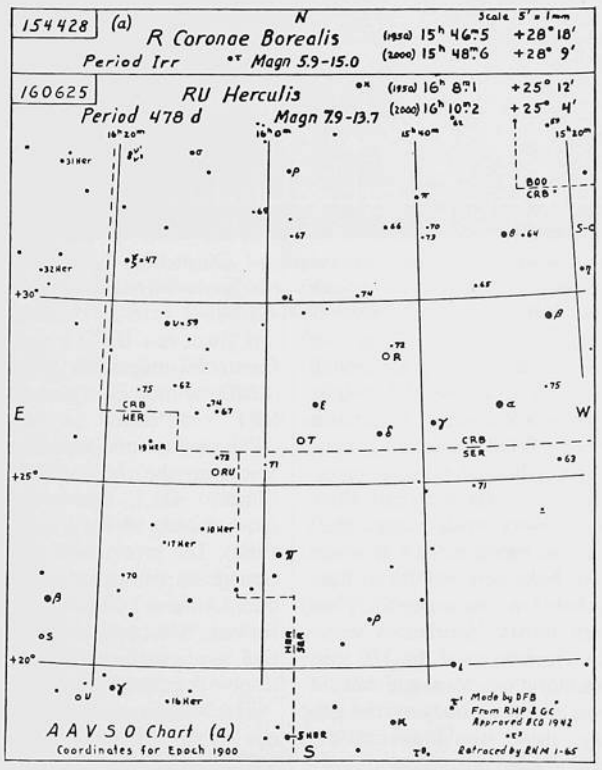
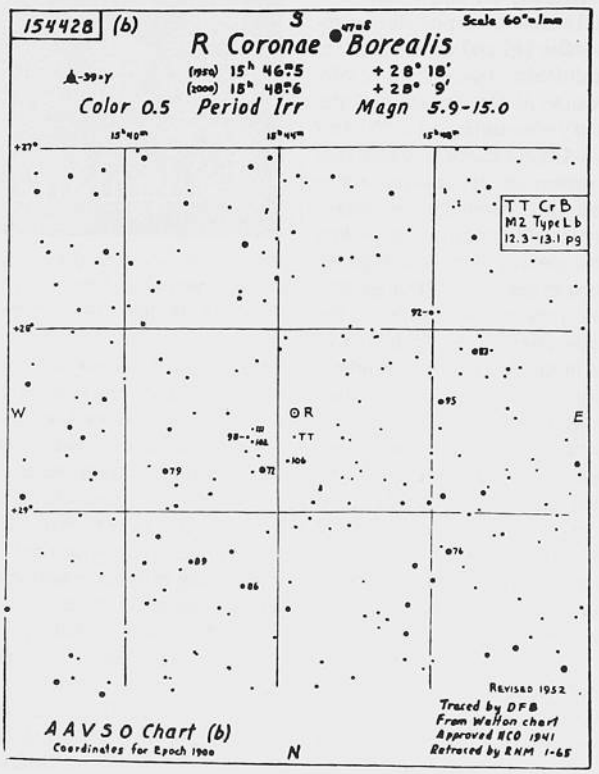
Amateur astronomy reaches out desperately for that special clear night. We are confirmed calendar watchers who plot the courses of our lives by the Moon's phase, sidereal time, and the chance position of celestial objects.



R Coronae Borealis, currently on the rise, is visible in this AAVSO "a" chart, which facilitates a wide-field binocular view. North is at top and east at left.



The R Coronae Borealis field as shown by a "b" chart, with south at top and west at left.

Scanning the Literature

June 1988 to January 1989

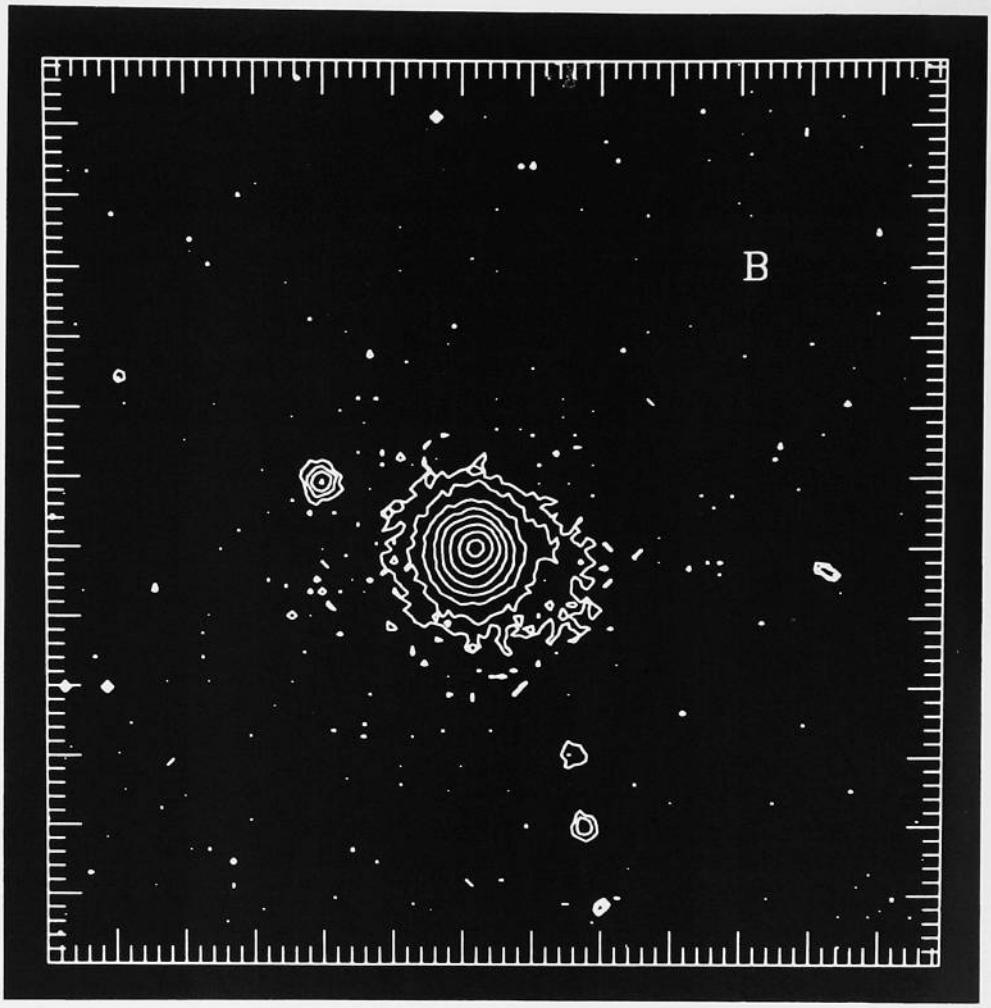
by Brian Skiff

A previously uncatalogued 13th-magnitude galaxy has been identified in Ursa Major. The galaxy has a very bright center evidently undergoing a sudden burst of star formation ("An Exceptionally Bright Starburst Nucleus" by Bruce Margon *et al.*, *Astrophysical Journal* (*ApJ*) **334:**597, 15 November 1988). The galaxy lies a few arcminutes northwest of π^1 Ursae Majoris at 8h38m23.7s +65° 07'15" (2000).

On the *POSS* prints the object looks almost like a star and hence was overlooked by Zwicky, Vorontsov-Veljaminov, and Nilson in their surveys of galaxies based on the *POSS*. However, it was not difficult at all to view in my 6-inch refractor and looked rather like a high surface brightness planetary nebula 10" or 20" across.

The spectrum of the galaxy slows strong emission lines of Hα, Hβ, O II, and O III—not unlike that of a planetary nebula. The Hβ and O III lines are redshifted by about 90Å because of the velocity of the galaxy, amounting to 5,700 km/sec. Around the first of this year I measured it several times using the Lowell 21-inch photometric telescope. In the yellow Stromgren *y* filter, which pretty much excludes the strong emission lines mentioned above, the magnitude is 13.4. Inclusion of the bright lines would brighten the galaxy by only one or two tenths of a magnitude.

Owners of large instruments keen to go after faint galaxy clusters may want to add Abell 2256 to their list. Daniel Fabricant, Stephen Kent, and Michael Kurtz present basic data for the cluster in "A Combined Optical/X-Ray Study of the Galaxy Cluster Abell 2256" (*ApJ* **336**:77, 1 January 1989). The cluster contains over a hundred galaxies between magnitude 15 and about 16.5 in a 30'-diameter area centered at 17h03.8m +78° 38.9' (2000). The cluster members have a mean redshift velocity of about 17,500 km/sec, which puts them at 230 megaparsecs (assuming 75 km/sec/Mpc). The paper includes precise coordinates and red magnitudes for each galaxy but no good finder chart. This should be straightforward to make using the coordinates plotted by a home computer.

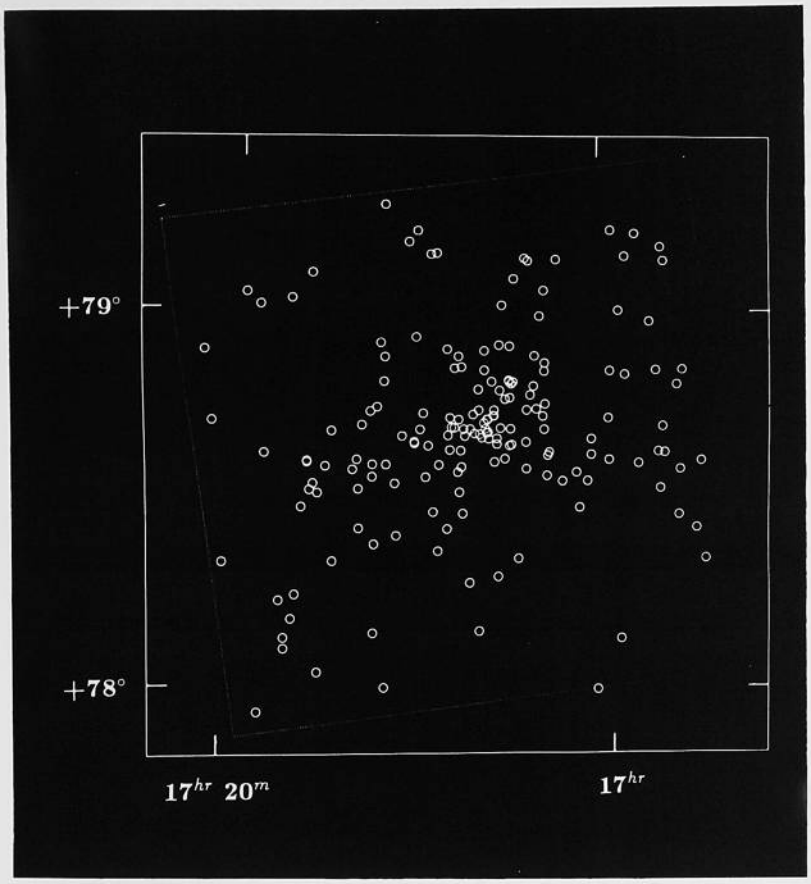


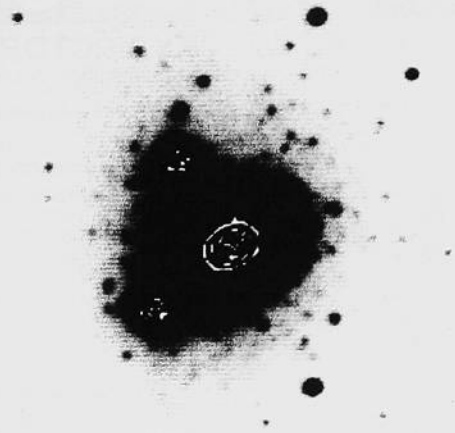
Bruce Margon's B-band CCD isophotal image of his newly-discovered starburst galaxy shows the considerable extent of the galaxy's low surface brightness outer halo. Large tick marks denote 10" and small ticks 2". North is up and east to the left in this image adapted from Margon's paper in Astrophysical Journal.

Another paper that really needed a good finder chart but does not have one is "A Catalogue of the Brightest Stars in the Field of M31" by E. M. Berkhuijsen *et al.* (*Astronomy & Astrophysics Supplements (A&A Suppl.)* **76**:65, November 1988). The group scanned 1.3-meter Tautenberg Schmidt plates to catalogue 11,500 stars complete to about V magnitude 19 (the brightest are magnitude 11.5). Although precise positions are again provided along with a very small plot of their distribution on the sky, it would have been very helpful to have included a photographic chart with the stars labeled. A separate list is given of the 370 stars brighter than V magnitude 14 over the main body of the galaxy; these would not be too hard to label on a chart.

In a remarkable study a group of Hawaiian astronomers led by J. N. Heasley has produced a fine color-magnitude diagram (CMD) of individual stars in an M31 globular cluster ("Photometry of Giant-Branch Stars in the M31 Globular Cluster G1," *Astronomical Journal (AJ)* **96**:1312, October 1988). The group used a CCD camera at the prime-focus of the 3.6-meter Canada-France-Hawaii telescope on Mauna Kea in excellent seeing to resolve the cluster.

The cluster is intrinsically one of the brightest known in M31 (or anywhere), having an integrated V magnitude of 13.4. It is located at 0h32m46.8s +39° 34'42" (2000), about 3°





Left: A diagram from Daniel Fabricant's recent ApJ paper shows the distribution of 172 galaxies surveyed in the Abell 2256 galaxy cluster. Many of these galaxies are visible in large backyard instruments. Above: A CCD image from the 3.6-meter Canada-France-Hawaii telescope shows the globular cluster G1 in the Andromeda Galaxy, one of the brightest such star groups known. The CCD detector's scale was 0.1 arcseconds per pixel. Adapted from J.N. Heasley's paper in Astronomical Journal.

from the center of the galaxy in a relatively uncrowded field. The CMD shows stars only at the top of the giant-branch of the cluster, the brightest of which are V~23.5. But that is enough to reveal that the members are similar to giant-branch stars in Milky Way globulars.

An old open cluster in the southern sky has also received a CCD photometric study ("BV Photographic and CCD Photometry of IC 4651" by Barbara J. Anthony-Twarog, *et al.*, *AJ* **95**:1453, May 1988). In this case a CMD was made by combining photographic data for the brighter stars with CCD data for the fainter stars. The photographic photometry, generally looked down upon these days, is of high quality. All the measured stars are identified on a photograph.

The brightest cluster stars are magnitude 10.5. From the new data, a distance of 1,050 parsecs is determined and an age of 2.4 billion years is derived.

Another photometric study confirms the existence of a sparse northern cluster ("UBV Photometry of the Open Cluster NGC 381" by Greg Crinklar and Fred Talbert, *Publications of the Astronomical Society of the Pacific* **100**:693, June 1988). A combination of photoelectric and photographic photometry shows the presence of sixty or more stars brighter than magnitude 16 at a common distance of approximately 950 parsecs. A good chart identifies the measured stars in the field of the cluster, which has an estimated age of 300 million years.

Two other winter Milky Way clusters have also received their first photometric study ("Photoelectric UBV and Photographic RGU Photometry of the Open Clusters NGC 1496 and NGC 1513" by G. del Rio and G. Heustamendia, *A&A Suppl.* **73**:425, June 1988). The photometry is complete for stars brighter than magnitude 16, and all the stars are identified on charts. The photoelectric measures here are probably okay, but the CMDs show that the photographic work (on a different color system) is "noisy," i.e. contains large accidental errors. Still, for visual purposes it's better than nothing.

For astrophotographers and others wishing to check magnitude limits, several new photometric sequences are now available around globular clusters ("Photoelectric UBVRI Sequences in the Magellanic Cloud Clusters Kron 3, NGC 330, NGC 1841, and NGC 2257" by Gonzalo Alcaino and Franklin Alvarado, *AJ* **95**:1724, June 1988; and "Photoelectric Sequences in the Region of the Galactic Globular Clusters NGC 362, NGC 1261, NGC 6656, and NGC 6809" by G. Alcaino, W. Liller, and F. Alvarado, *AJ* **96**:139, July 1988). Readers will recognize the last two NGC numbers as belonging to M22 and M55 in Sagittarius.

Both papers give a list of stars over a range of magnitudes and colors as faint as magnitude 16 in the field of each object. All are identified on excellent photographic charts.

The September 1988 *ApJ Supplement* is given over to a long-awaited publication ("The Guide Star Photometric Catalog. I." by Barry Lasker, Conrad Sturch, and fourteen others, *ApJ Suppl.* **68**:1). This is the catalogue of photometric standards used to calibrate the magnitudes of stars for the massive Space Telescope Guide Star Catalog. The present work consists of 1,477 photoelectric sequences (B and V magnitudes) measured at four observatories in the northern and southern hemispheres.

Nominally each sequence contains six stars uniformly spread between V magnitude 9 and 15. In practice, many have an extra star at the faint end, while others lack one or more from the basic six. For the faintest stars, the errors are near 0.1 magnitude, while the brighter stars are within 0.03 or so. Much of this publication consists of tables showing precise coordinates, magnitudes, and colors for the eight thoursand-plus stars, plus finder charts for each field.

The main catalogue (which has just become available) contains 20 million or more stars complete to V magnitude 12.5 or so and reaches to 15 or 16 at high galactic latitudes. This density of stars is necessary to provide a sufficient number of stars to enable the HST tracking system to lock on to two stars within 15' wherever it points in the sky. Don't expect to see this one in print; instead magnetic tape and laser-disk versions are anticipated.

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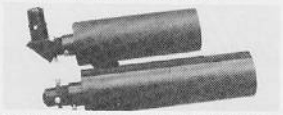

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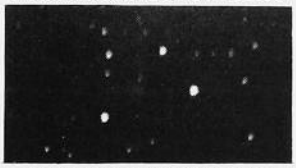

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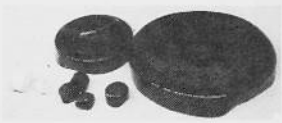

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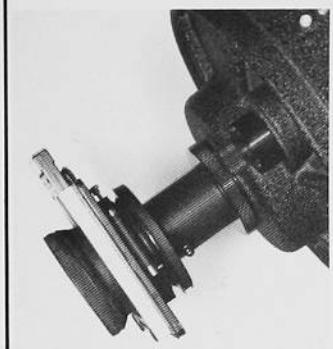

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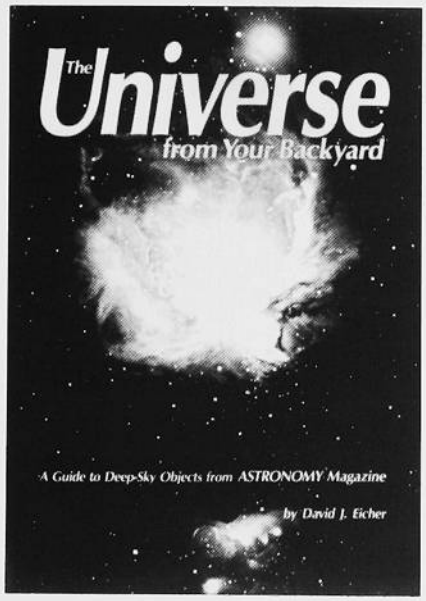

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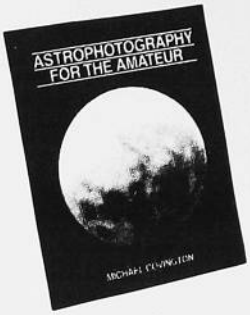

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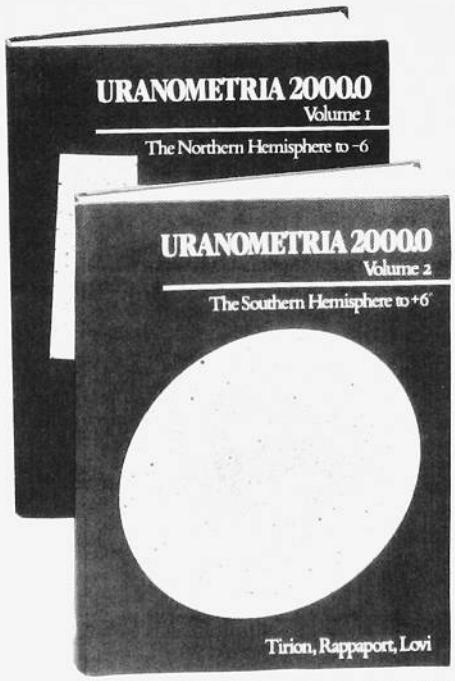

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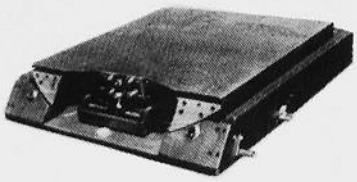

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